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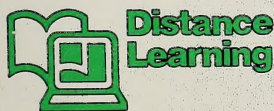


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BIOLOGY 20

Biomes and Ecosystems

Module 2



Alberta
EDUCATION



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Biology 20

Module 2

Biomes and Ecosystems



**Distance
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EDUCATION

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Module 2
Biomes and Ecosystems
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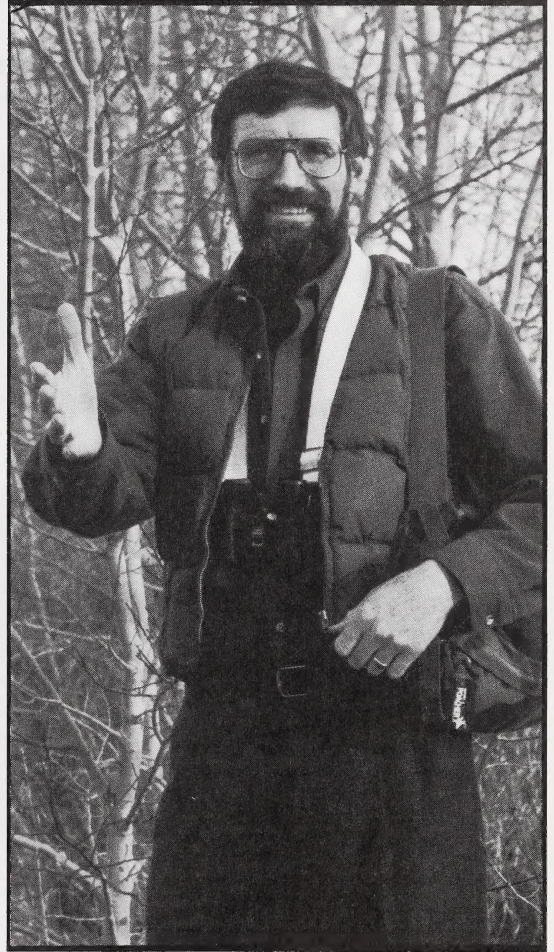
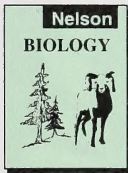
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Welcome to Module 2

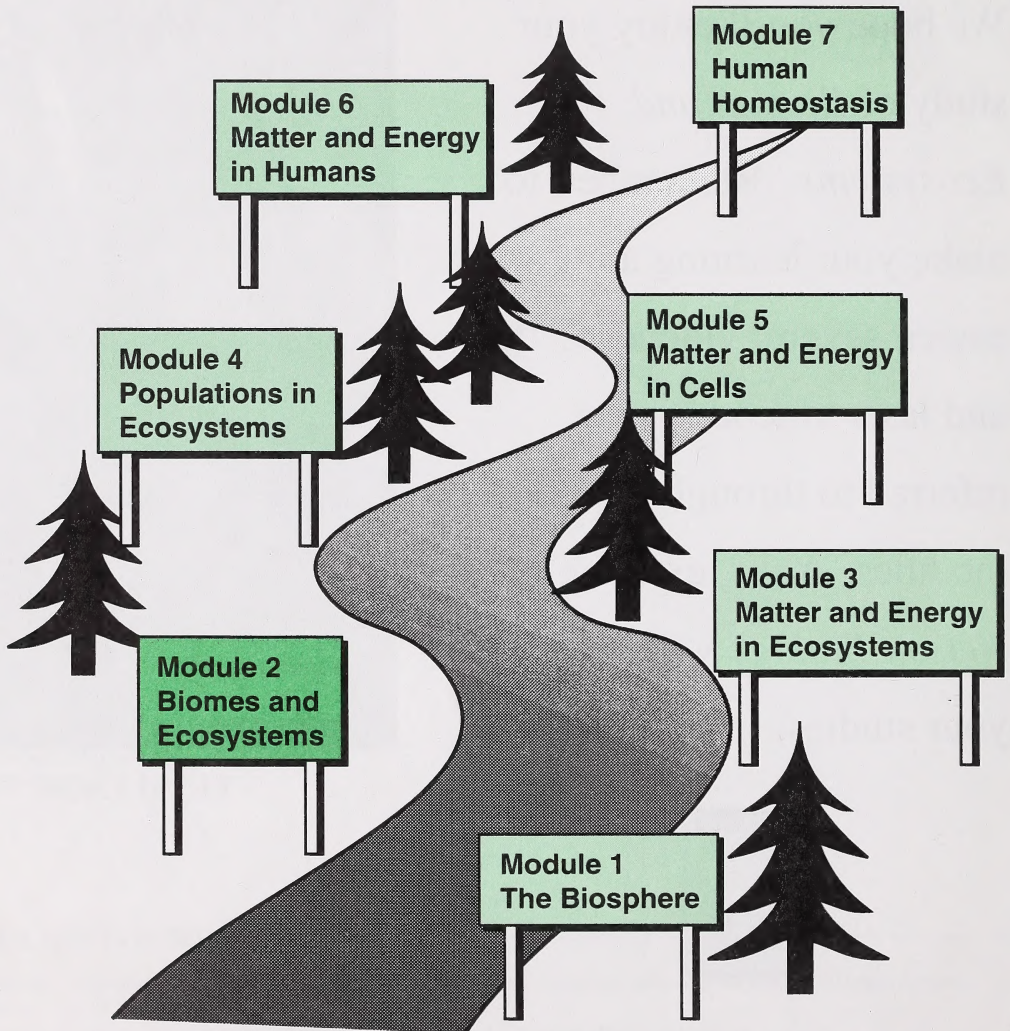
We hope you'll enjoy your study of *Biomes and Ecosystems*. Remember, to make your learning a bit easier, several videocassettes and laser videodiscs are referred to throughout the modules. Your textbook *Nelson Biology* will enhance your studies.



Good Luck!

COURSE OVERVIEW

This course contains seven modules. The module you are working in is highlighted in a darker colour.



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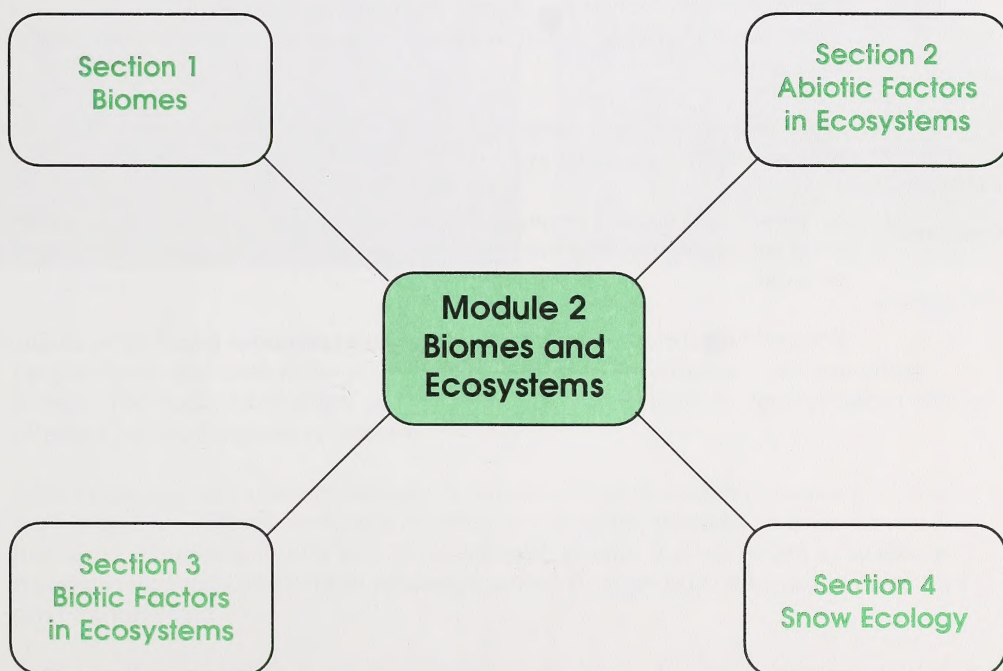
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MODULE OVERVIEW

Have you ever travelled to the Rocky Mountains? What type of climate and plant life could you observe there? When you walk outside in the morning, the air feels colder in the mountains and the scent of spruce and pine trees is strong. What about all those evergreen trees? They're everywhere – along the highway, surrounding the campsites, on the ski hills, and along the hiking trails.

Have you ever been to the Badlands near Drumheller? It isn't as cold as in the mountains and there are no evergreen trees. It looks like a desert with strange-looking rock formations. These two areas look and feel very different, yet they are barely 200 kilometres apart.

This module looks at the characteristics that make up these and other areas in Alberta. From the previous module you have gained an understanding of the biosphere and the relationships in it. This module will explore the different physical areas which make up the biosphere and the different ecosystems in each region. From a big, whole-earth picture you will begin to focus on specific parts.



Evaluation

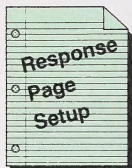
Your mark in this module will be determined by how well you complete the assignments at the end of each section. You must complete all assignments. In this module you are expected to complete four assignments. The mark distribution is as follows:

Section 1 Assignment:	25 marks
Section 2 Assignment:	25 marks
Section 3 Assignment:	25 marks
Section 4 Assignment:	<u>25 marks</u>

TOTAL 100 marks

When doing your assignments, work slowly and carefully. If you are having difficulties, go back and review the appropriate section.

Read all parts of your assignment carefully. Plan and do your rough work on your own paper. Revise and edit your responses; then set up your final copy for submission on your own paper. Lined looseleaf is recommended. Make sure your answers are neat and organized, with wide left margins and space for teacher comments after each assignment.



When you see this icon, ideas and details are provided to help you set up and organize your answer in a certain way.

Before submitting your responses, be sure to proofread them carefully to ensure they say what you want, that they are neat and clear, and that they are complete and missing no material.

You will be submitting **only** your **assignment response pages** for evaluation.

Biomes



WESTFILE INC.

Do you know that both these photographs were taken in Alberta? Can you guess where? The Rocky Mountains and the Badlands around Drumheller represent two very different physical regions or biomes.

Alberta has a wide variety of biomes, in fact more than any other province in Canada. Each biome has its own biotic and abiotic characteristics, basically its own climate and life forms. Human activities also vary with each biome. It is important to be able to recognize the total composition of biomes so that changes caused by human activities can be anticipated.

In this section you will become familiar with some of the unique characteristics of major biomes. You will examine the abiotic and biotic factors that make up biomes of Alberta and Canada. You will also study the human impact on one of the major biomes of the world – the tropical rainforest.

ACTIVITY

1 Characteristics of Terrestrial Biomes



In this activity you will learn some of the characteristics associated with biomes by reading in your text and making some observations about your environment. Read the section titled Biomes of Canada on pages 67 and 68 of your text and answer the following questions.

1. What is a biome?
2. Biomes are made up of abiotic and biotic components. Identify two abiotic and biotic components for the tundra biome.
3. What does circumpolar mean?
4. Rank the biomes of Canada from lowest to highest in terms of the amount of precipitation.
5. Which members of the biotic community are found in two biomes?
6. Identify the two biomes that make up 80% of the land surface in Canada.
7. Using Table 3.1 on page 67 of your text and the factors in the following table, identify the biome and check whether the factor is abiotic or biotic. An example is done for you.



BIOME	FACTOR	ABIOTIC	BIOTIC
tundra	Arctic circumpolar	√	
	soils hold less water		
	rapid-flowering plants		
	same latitude as grassland		
	Plains bison		
	short growing season		
	deciduous trees		
	woodpeckers		
	precipitation 35-40 cm/y		
	coniferous trees		
	increased sunlight strikes forest floor during spring and fall		

8. In the following tables check the factors characteristic of the region where you live.

Science Skills

- ☐ A. Initiating
☐ B. Collecting
☒ C. Organizing
☒ D. Analysing
☐ E. Synthesizing
☐ F. Evaluating

TABLE 2.1 – Abiotic Factors

LOCATION	CHECK
Edmonton or north of it	
South of Edmonton and north of Calgary	
Calgary or south of it	
Rocky Mountains	
Cypress Hills region	
PRECIPITATION	
less than 35 cm/y	
35 to 40 cm/y	
greater than 40 cm/y but less than 100 cm/y	
100 cm/year or more	

TABLE 2.2 – Biotic Factors

DOMINANT PLANT LIFE	CHECK
coniferous trees	
deciduous trees	
grasses	
ANIMAL LIFE	
hares, lynx, moose	
deer, beavers	
pronghorn antelope	
mountain goats, bighorn sheep	

coniferous – describing trees which remain green throughout the year and which have cones and needles

deciduous – describing trees which lose their leaves sometime during the year

9. Summarize the abiotic and biotic factors by stating the location, the amount of precipitation, and the dominant plant and animal life characteristic of the region in which you live.
10. Does your summary of factors in question 9 match up with one of the biomes discussed? If yes, identify the biome where you live.

Check your answers by turning to the Appendix, Section 1: Activity 1.

You may not be able to identify the biome where you live because there are other regions in Alberta which have not been discussed yet. Alberta is unique in Canada; no other province has as many different biomes.

ACTIVITY

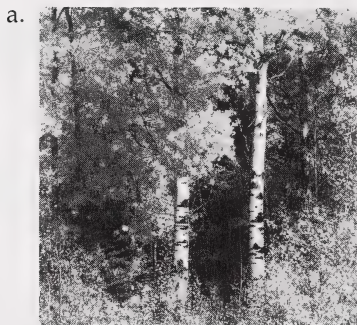
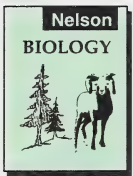
2 Canadian Biomes

You have looked at the Rocky Mountains and the Drumheller Badlands in the previous activity.

1. Can you describe some other land regions found in Canada? You may recall these from lessons in geography or from your travels.

Hint: What kind of land region makes up southern Alberta and southern Saskatchewan? And what about most of Manitoba and Ontario?

2. It is a common practice in science to identify biomes on the basis of vegetation. Use Table 3.1 on page 67 of your text to identify the biomes in the following pictures. Briefly explain why you think it is that biome.



PUBLIC AFFAIRS BUREAU



PUBLIC AFFAIRS BUREAU



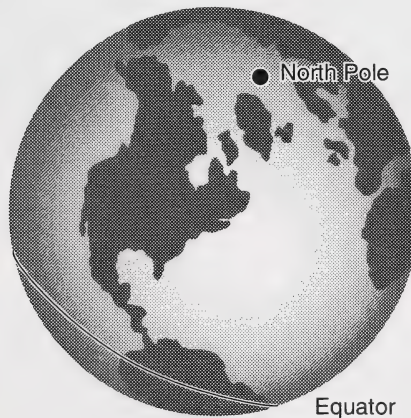
Besides the biomes identified in question 2, there are other biomes such as chaparral, temperate rain forest, semidesert, and mountain that exist in Canada.

The central plateau of British Columbia has a biome called chaparral that is not described in your text. The characteristics of this biome are controlled by the Pacific Ocean and coastal mountains. Warm, moist air moves inland from the ocean and rises over the mountains. The air cools somewhat and loses much of its moisture as precipitation. By the time the air reaches the interior plateau, it is still moderately warm but very dry. Consequently this biome has hot, dry summers and mild winters. This region of temperature and moisture controls the biotic factors. This biome is called chaparral.

Remember the photograph of the Badlands at the beginning of this section? This is a semidesert biome. It has wide ranging temperature extremes, low irregular precipitation, and dry soil which is low in nutrients.

The mountain biome is unique; it's actually a collection of biomes. You'll look more closely at the mountain biome next.

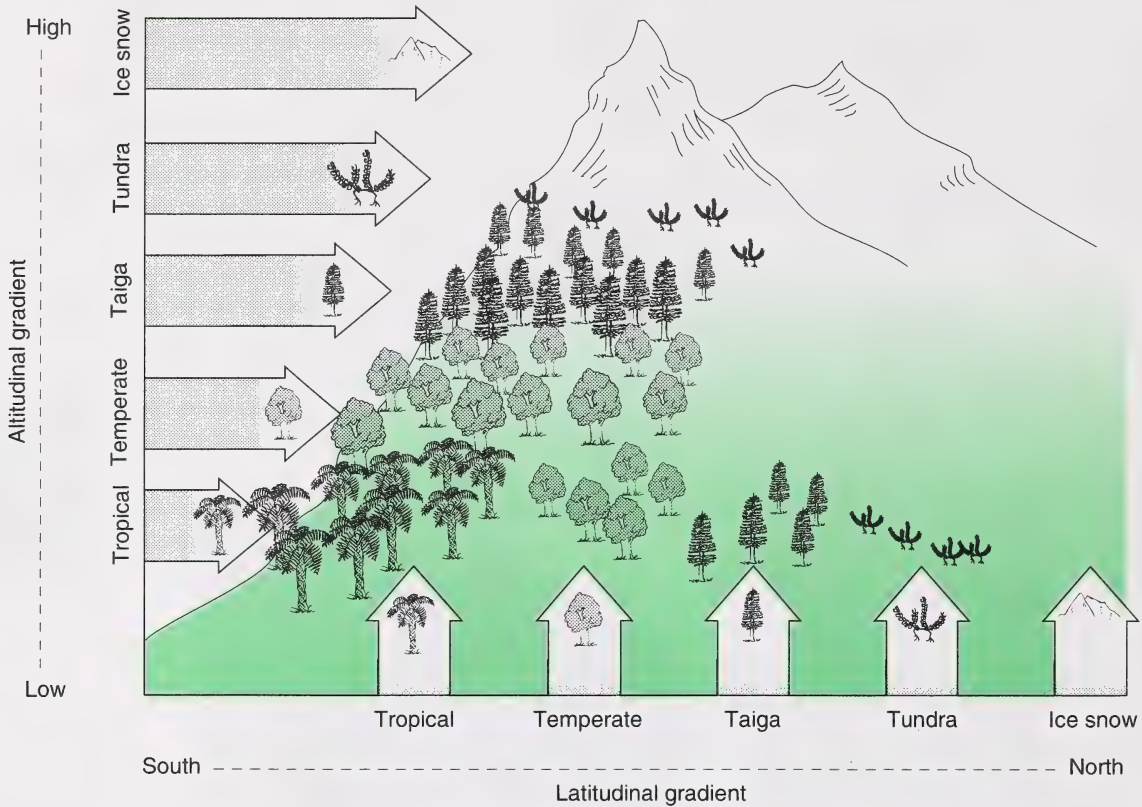
3. Latitude has an effect on world biomes. Examine the following diagram.



- a. Where is 0° latitude located?
- b. Where is 90° latitude located?
- c. As you move from 0° to 90° latitude, which direction are you moving?

Thus far you have looked at seven biomes found in Canada. These biomes include tundra, boreal forest, mixed woodland forest, grassland, temperate rainforest, desert, and mountain. Of these biomes, tundra, boreal forest, grassland, mountain, and desert are all found in the province of Alberta.

4. Look at the following diagram and notice how similar biomes can exist in two different places.



- Describe the relationship which exists between latitude and biomes with respect to temperature and the amount of plant life.
- What is the relationship between altitude and biomes with respect to temperature and the amount of plant life?
- The effect of latitude on biomes can be compared with the effect of altitude on biomes with respect to temperature and the amount of plant life. Explain this statement.

Generally temperature decreases 1°C for each 150 metre increase in elevation. Think of this the next time you plan a hike in the mountains.

Check your answers by turning to the Appendix, Section 1: Activity 2.

So where does one biome end and another begin? Biomes do not have clear-cut boundaries. If you travel from one biome to another, you will usually observe only a gradual change. In Alberta, there is an entire region which shows this gradual change. It is called the aspen parkland and occupies much of central Alberta. An area of change or transition between biomes is called an **ecotone**.

ecotone – area
of transition
between biomes



Alberta's Aspen Parkland

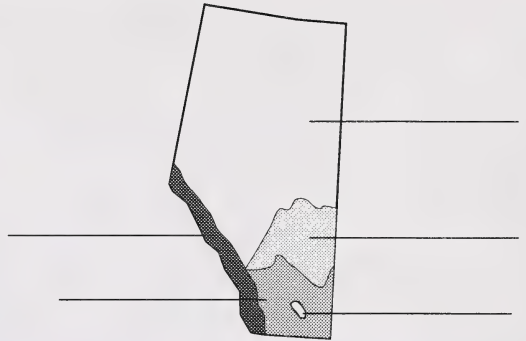
TABLE 2.3 – Abiotic and Biotic Factors of Aspen Parkland

NAME	ABIOTIC FACTORS	BIOTIC FACTORS
Aspen Parkland	• short, moderately warm summers • long, cold winters • precipitation 40 – 45 cm • soil may have a high salt content	• aspen poplar trees • whitetailed deer • willow trees • sharp-tailed grouse • red-tailed hawks • garter snakes

In some cases an ecotone may be quite large, like the aspen parkland. In other cases it may not exist at all if the difference between two biomes is clear.

5. Aspen parkland is located between which two biomes in Alberta?

6. Here is a map of Alberta. Can you identify the location of the Alberta biomes of grassland, mountain, desert, and boreal forest? What about the aspen parkland? Using your past experiences, knowledge of biomes, and relationship of the biomes with respect to latitude, label the biomes of Alberta.



Check your answers by turning to the Appendix, Section 1: Activity 2.

Can you identify the biome where you live? How does it compare with the Rocky Mountains and the Badlands? Does the region where you live have the abiotic and biotic characteristics discussed in this activity?

ACTIVITY

3

Human Impact on Biomes



WESTFILE INC.

How important are Alberta's biomes to you? Take a look at this highly productive biome and answer the next two questions.

1. What biome supports production of major crops like wheat and barley?
2. What biome is a major producer of timber for building materials?

Check your answers by turning to the Appendix, Section 1: Activity 3.

If biomes are important, are they worth protecting? The answer is naturally, yes. But wait a minute! Does this mean humans can change, damage, or even destroy something as large as a biome? Unfortunately the answer to this question is also yes. And it is happening right now while you work on this module.



Courtesy of D. Merrills

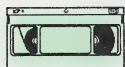
When you think of forests, what does it bring to mind? Do you think of the paper you're writing on, the pencil you're using, the chair or the desk you're sitting in, the rubber-soled shoes you're wearing? What about the oxygen you're breathing?

All these things depend on forests.

PATHWAYS

If you have access to the video *This Living World, Volume 2: The Forest* do Part A.
If you do not have access to this video, do Part B.

Part A



Watch the video *The Forest* and answer the following questions. It is recommended that you read through the questions first so you know what to watch for as you view the video. Besides the answers to these questions, watch for examples of science, technology, and careers.

Science Skills

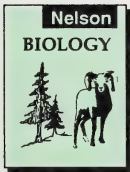
- ☐ A. Initiating
- ☒ B. Collecting
- ☒ C. Organizing
- ☒ D. Analysing
- ☐ E. Synthesizing
- ☐ F. Evaluating

3. How much of the world's forests are in Canada?
4. Besides growing trees, in what other ways do forests benefit the biosphere?
5. Canadian forests are an important resource for the wood products industry, but what other growing industry depends in part on forests?
6. Describe the methods of harvest and transportation used in early Canadian forestry and logging.
7. What modern methods of logging and transportation are used in forestry today?
8. Compare forest harvest in Nova Scotia to forest harvest in British Columbia.
9. Describe an old growth forest.
10. Why are old growth forests common in British Columbia but not found in Nova Scotia?
11. What forestry industry in Nova Scotia involves annual planting and cutting of relatively small evergreen trees?
12. About how many years are needed to grow a Christmas tree?
13. What is a Forestry Management Agreement or FMA?
14. Describe two-pass logging.
15. Each year Canadian forests are harvested for timber products, but other factors also remove many hectares of trees. Compare the annual forest loss by harvest to fires, to insects, and to disease.

16. Fire may occur naturally or be caused by humans. What is a common natural cause of forest fire?
17. What school in Alberta offers training courses in fighting forest fires?
18. How do forest fires create wildlife habitat?
19. How are jack pine trees naturally adapted to forest fires?
20. Describe silviculture as a part of modern forestry.

Check your answers by turning to the Appendix, Section 1: Activity 3.

Part B



Humans affect biomes by such practices as agriculture and forestry. Read pages 58 to 60 in your text and notice the many positive and negative effects of human practices. Now read through the questions and answers (in Appendix) for Part A and notice the development of management practices in just one biome – the boreal forest in Canada. Finally read the Social Issue on page 63 in your text. By now you should have an appreciation for the impact humans can have on biomes and the need for responsible long-term decisions.

Tropical Rainforest: A Global Issue

A similar controversy exists in tropical rain forests in Central and South America. Look at the following and notice how different groups of people depend on the same forest.

People in the industrialized world need forests for timber products and medicines. Forests also remove air pollution and stabilize climate.

Settlers clear forests and move onto the land to escape overcrowded slums and poverty.

Forest-dwelling aboriginal people depend on the forest for all their needs – food, shelter, and clothing.

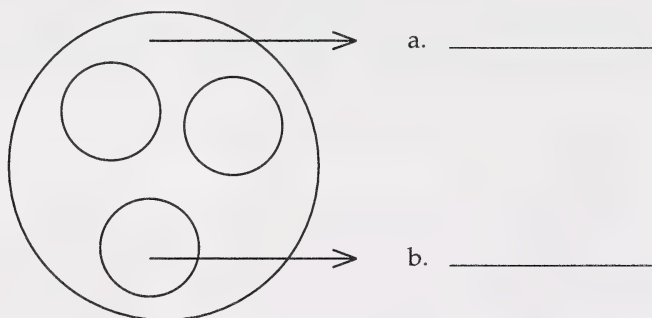
Do you now realize how important forests are to you? They help maintain climate and provide building materials, paper products, foods, and medicines. Total destruction of the tropical rainforests is possible in the near future. The rainforests are important to the whole world not just the people living in them. Can you see a role for yourself in contributing to saving the forests? You can do your part to help out! Think globally, act locally!

Follow-up Activities

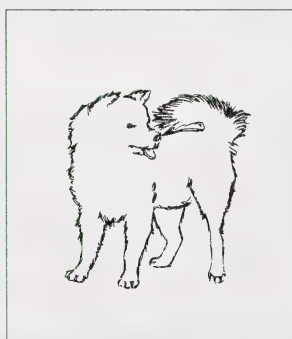
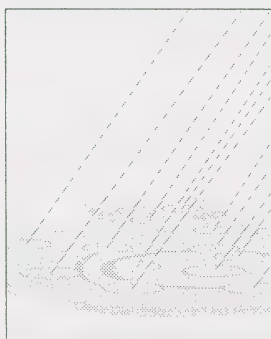
If you had difficulty understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

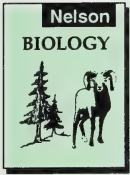
1. The biosphere is the area on earth where life exists. There are many different biomes found in the biosphere. Label the biosphere and the biome in the following diagram.



2. Biomes are made up of abiotic and biotic factors. Remember, biotic means living and abiotic means nonliving. Identify each of the following as being an abiotic or biotic factor.



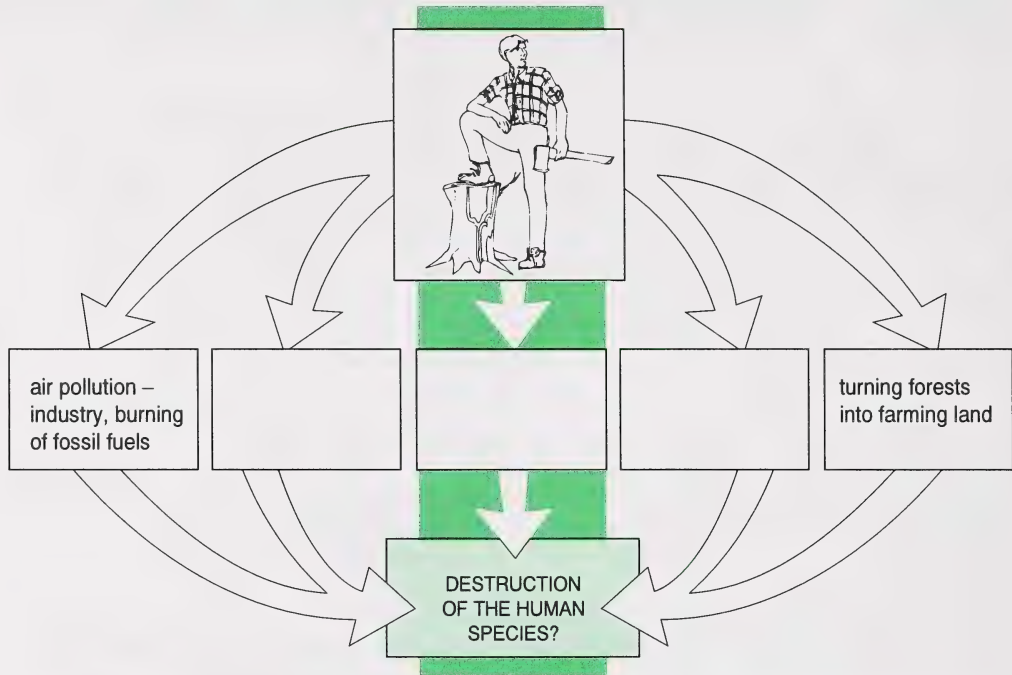
a. _____ b. _____ c. _____



3. Use Table 3.1 and Figure 3.2 in your text to identify each of the biomes by examining the abiotic and biotic factors.

BIOME	ABIOTIC AND BIOTIC FACTORS
	• grasses • less precipitation than mixed woodland • hawks • rattlesnakes
	• widest range of altitudes • collection of biomes • mountain goats • bighorn sheep
	• mild winters • hot, dry summers • fruit-eating birds • seed-eating rodents
	• low temperatures • precipitation of 10-12 cm/y • polar bears • seals
	• wide-ranging temperature extremes • low irregular precipitation • cacti • lizards, snakes
	• south of boreal forest • precipitation of 100 cm/y • deciduous trees • woodpeckers
	• warm temperatures • high humidity • giant coniferous trees
	• south of tundra • precipitation of 35-40 cm/y • evergreen trees • moose

4. The human species has played a major role in destruction of the forest biomes. In the following flow chart, list ways in which the human species has contributed to the destruction of the forests.



Check your answers by turning to the Appendix, Section 1: Extra Help.

Enrichment

Do one of the following activities.

1. Find a natural area of the biome where you live and observe the area for about half an hour. Identify as many abiotic and biotic factor as you can; be as specific as possible. Don't forget plants. How many kinds of plants are there in your biome?

What kinds of animals live there? Look for food chains and food webs. Even a backyard in a big city may have resident plants and animals (birds, insects). In your observations be aware of seasons and changes that will occur. What will happen in winter? Also look for signs of human impact and how this has altered the biotic and abiotic characteristics of your biome.

2. Using the following map of Canada, locate and label the different biomes found in the country. Use whatever text references you have available to you. Notice how the number of biomes increases in Alberta and British Columbia. Can you guess why?



3. Take a field trip to either the Rocky Mountains or the Badlands to study one of these biomes.
4. Read through your local newspaper and cut out articles which report on the various biomes. Make a collage with the articles.
5. Become actively involved by joining a group or club involved with environmental concerns. Following is a list of various environmental organizations which you could contact.

- Alberta Junior Forest Warden Assoc.
Bramalea Building, 10th floor
9929 108 Street
Edmonton, AB
T5K 2M4
(ph. 427-2545)

- Rainforest Action Group of Edmonton
51222 RR 224
Sherwood Park, AB
T8C 1H3
(ph. 922-2127)

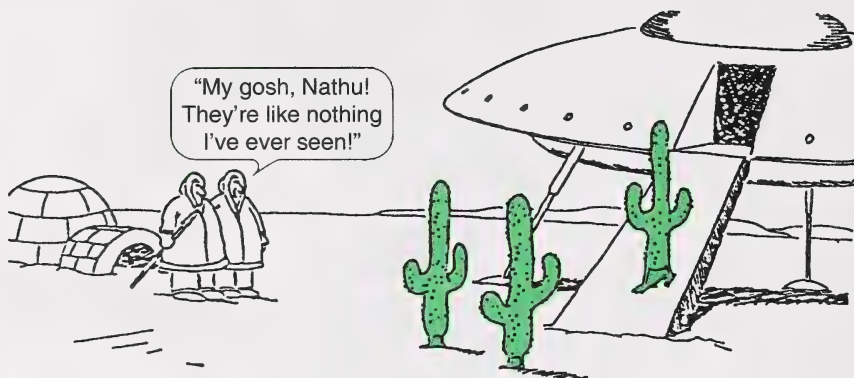
- Calgary Rainforest Group
208 Canniff Place SW
Calgary, AB
T2W 2L8
(ph. 232-2075)

- Lethbridge Naturalist Society
Box 1691
Lethbridge, AB
T1J 4K4

Better yet, form a club of your own which takes an active role in the environment.

Check your answers by turning to the Appendix, Section 1: Enrichment.

Conclusion



This section focussed your attention on biomes and the abiotic and biotic factors associated with each. The photographs of the Rocky Mountains and the Badlands showed two biomes found in Alberta. Hopefully you have gained a better understanding of how the human species has affected the biomes – especially the forests of the world.

25

Section 1 Assignment: Biomes

Review the Evaluation information found in the introductory pages of this module.

It is important to number and clearly identify each page with the following information at the top:

Biology 20 – Module 2

Section 1 Assignment

Page #

Name and ID#

Be sure to write legibly. Leave a wide left margin and number all of your pages.

¹ Universal Press Syndicate for the cartoon from "The Far Side", 1985. Far Works Inc. Reprinted with permission of Universal Press Syndicate. All rights reserved.

Science Skills

- ☐ A. Initiating
☐ B. Collecting
☒ C. Organizing
☐ D. Analysing
☐ E. Synthesizing
☐ F. Evaluating

1. Describe the difference between the biosphere and a biome? **(3 marks)**

Reproduce the science skills assessment box after your response to this question.

Remember to indicate your evaluation of your skill level for each identified science skill.

Be sure to include the spaces for teacher assessment.

Self: A.		B.		C.		D.		E.		F.	
Teacher: A.		B.		C.		D.		E.		F.	

2. Describe the specific abiotic and biotic factors that affect the type of biome an area will be? **(4 marks)**

3. Rank the following biomes from coldest to warmest in terms of temperature. **(3 marks)**

- boreal forest • mixed woodland forest • chaparral
- desert • temperate rain forest • tundra

4. For each of the biomes listed in question 3, describe the main type of plant life found there. **(3 marks)**

5. Explain why a mountain biome is a "collection of biomes." **(2 marks)**

6. What happens to temperatures and plant life as altitude increases or as you move further from the equator? **(2 marks)**

7. Identify three ways in which tropical rain forests affect you. **(3 marks)**

8. What seems to be the main reason for destruction of the tropical rain forests? Explain your answer. **(3 marks)**

9. Describe two ways which could prevent the total destruction of the rain forests. **(2 marks)**

SECTION

2

Abiotic Factors in Ecosystems



Courtesy of K. Merrills

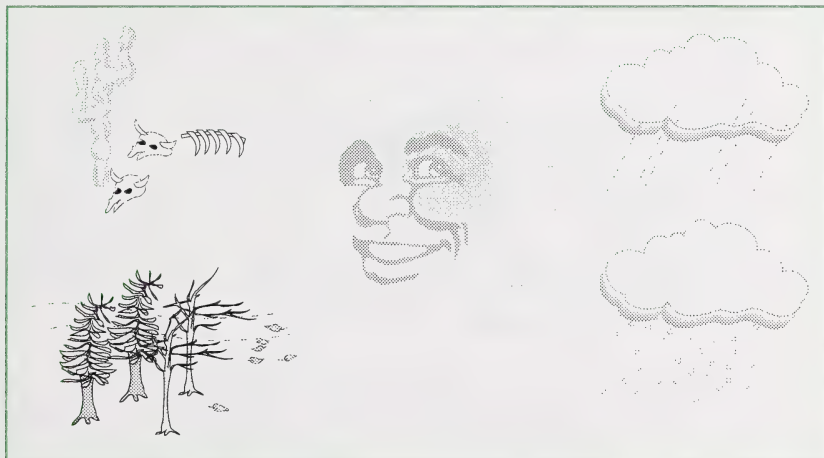
Have you ever walked outside in the winter and been hit with cold, blowing snow? Have you noticed how much warmer it feels when the wind dies down? Have you been suntanning in the summer when the sun disappears behind the clouds? These are close encounters with abiotic factors. So what do abiotic factors have to do with living organisms? In the last section you learned about different biomes and their characteristics. In this section you will examine how abiotic factors contribute to the formation of various biomes. You will investigate the abiotic factors of a terrestrial ecosystem and an aquatic ecosystem. You will also continue your study of the human impact on the ecosystem.

As you study this section, keep in mind that more than any other organism, humans have altered the face of the earth to suit their needs. They actually have the ability to change the characteristics of entire biomes and have already done so. Usually the human influence begins at ecosystems and expands. Sometimes the changes go out of control. This is why it is important for you to be able to recognize the different characteristics and how they interact. You'll become familiar, maybe even an expert, at both the natural and the unnatural world around you.

ACTIVITY

1 Matter + Energy = Biome

How do the abiotic factors influence the formation of a terrestrial biome? In this activity you will carry out an investigation to measure the abiotic factors in a natural site near you.



Science Skills

- ☐ A. Initiating
- ☒ B. Collecting
- ☒ C. Organizing
- ☒ D. Analysing
- ☒ E. Synthesizing
- ☐ F. Evaluating

Investigation: Exploring the Nonliving Land

Objective

Measure abiotic factors in a terrestrial ecosystem.

Background Information

In this investigation you will be using various types of materials to measure abiotic factors. These materials and their functions include

- thermometer → to measure temperature
- rain gauge → to measure precipitation
- litmus paper → to measure **pH**
- paraffin light meter (photometer) → to compare light intensities

pH – measure of how acidic or basic a substance is

PATHWAYS

If the time of year is appropriate, you are encouraged to do Part A, if at all possible. If it's not possible, do Part B.

Part A

Materials

The following materials are needed to complete this investigation:

- reinforced thermometer
- wire coat hanger or other similar wire*
- wire cutters or pliers*
- mineral oil*
- petri dish
- wide range litmus paper (red and blue)
- 100 mL distilled water (tap water may be used)
- * supplied by student
- shovel*
- 4 test tubes
- 4 small funnels
- 10 mL graduated cylinder
- 2 blocks of paraffin wax
- aluminum foil
- elastic bands

Before you begin your investigation you will need to construct four simple rain gauges and a paraffin light meter (photometer). Directions for making these devices follow.

Rain Gauge

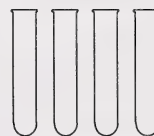
A very simple but effective rain gauge can be constructed by using the following:



coat hanger or
heavy wire



heavy wire cutters
or pliers



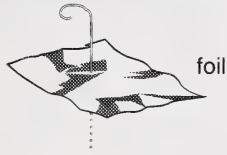
4 test tubes

Cut wire into 15 cm sections and carefully bend a 90° loop in one end. Make the loop large enough for the test tube to fit loosely.



Do not bend the wire over or around the glass test tube.

Carefully push the wire loop through a piece of foil and into the ground.



Stand the test tube in the loop.



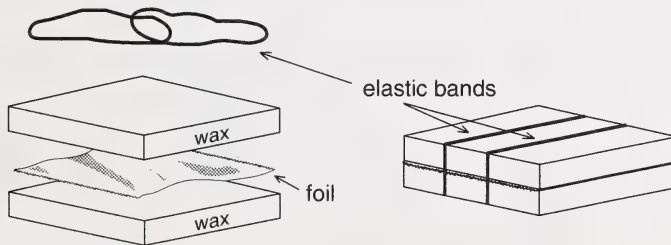
The foil serves to mark the rain gauge so you won't accidentally trip over it. Now add the funnel.

Photometer

A simple photometer can be constructed from the following materials:

- 2 blocks of paraffin wax
- elastic bands
- piece of aluminum foil

Make an aluminum foil and wax sandwich; fasten it together with the elastic bands.



Note: The two pieces of wax should be the same thickness.

Here's how it works. If two lights shine on your photometer, the brighter one will produce the shadow of the foil on the wax facing the dimmer one.



Try it. If you turn over the device, the piece of wax near the dim bulb will still be darker.



Procedure

Select two natural sites near you which have different characteristics (i.e., different plant and animal life). A forested site with a grassy site beside it would be ideal. If you live in a town or city, ravines and vacant lots are possible sites of study. If necessary, make sure you get permission from the proper authorities to do your study in your selected area. You will dig a shovel-sized hole, 30 cm deep, at each site. Remember to fill in the hole after the investigation.

1. Identify some noticeable differences between the two sites you have chosen. Describe the difference in dominant plant life?

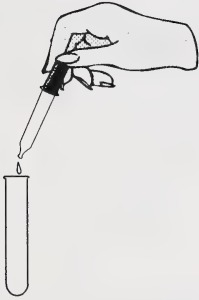
At each of the study sites, measure the abiotic factors of temperature, precipitation, light intensity, and pH.

Temperature At, Above, and Below Ground Level

Measure the temperature at the surface, 30 cm below, and 2 m above the ground. Leave the thermometer in each location for two minutes and record temperature immediately after removal. Take measurements three times at each level. Record data in the appropriate table.

2. Why is it important to read the thermometer immediately after removal?





Measuring Precipitation

Before you set out your rain gauges add a few drops of mineral oil to the tube of each gauge. This oil will float on top of any water and prevent evaporation. Place a rain gauge in various locations in each of the sites. After a rainfall, record the amounts of precipitation in each of the gauges. Measure the amount of rain with a 10 mL graduated cylinder.

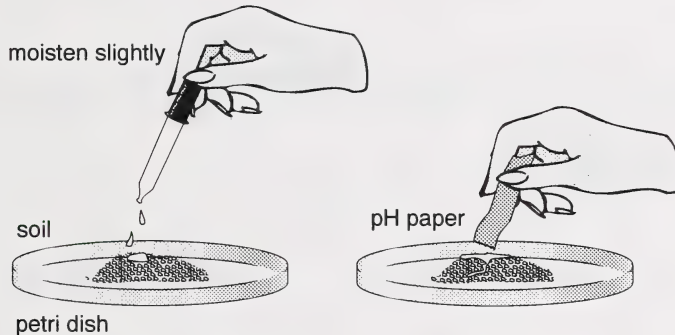
Soil pH

The soil must be moist in order to test for pH. Dampen with distilled water if necessary. Use litmus paper and test the soil at the surface and 30 cm below. Take three measurements for each level. The colour of the litmus paper will allow you to determine whether the soil is **alkaline** (blue colour), **acidic** (red colour), or neutral. Blue litmus paper turns red in an acid. Red paper turns blue in a base.

Note: The terms alkaline and basic mean the same thing.

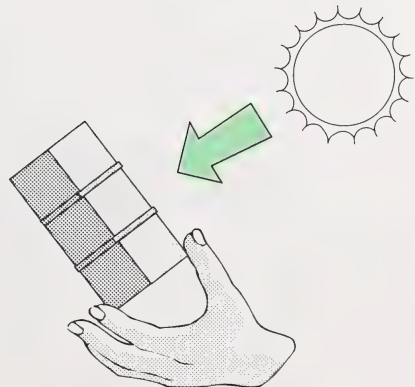
alkaline – pH
above 7.0

acidic – pH
below 7.0



Using a Simple Photometer

Notice if there is a distinct difference in the shading of the paraffin blocks. The greater the difference, the more intense the light. Experiment by trying your photometer in bright sunshine and then in the shade.



If your two sites are directly beside each other, stand at the boundary of the two sites and determine which has a greater light intensity. If your sites are not beside each other, you will have to experiment with the photometer in different areas of each site and make an educated guess as to which site has greater light intensity.

Observations

Site 1 Description: _____

Site 2 Description: _____

TABLE 2.4 – Temperature Measurements

	Site 1 (°C)			Site 2 (°C)		
	trial 1	trial 2	trial 3	trial 1	trial 2	trial 3
2 m above						
surface						
30 cm below						

TABLE 2.5 – Precipitation Measurements

	Site 1 (mm)	Site 2 (mm)
Gauge 1 location:		
Gauge 2 location:		
Gauge 3 location:		
Gauge 4 location		

Note: Location refers specifically to where you put the rain gauge (e.g., at ground level, in the trees).

TABLE 2.6 – pH Measurements

	Site 1 (pH)			Site 2 (pH)		
	trial 1	trial 2	trial 3	trial 1	trial 2	trial 3
surface						
30 cm below						

TABLE 2.7 – Light Intensity

	Site 1	Site 2
At ground level, which site has a greater light intensity? (Use a checkmark to answer.)		

Analysis and Interpretation

3. a. Calculate the average values for temperature and precipitation. For pH identify the site as acidic, alkaline, or neutral. Use Table 2.8 to record your data.

TABLE 2.8 – Comparative Observations

ABIOTIC FACTOR	SITE 1 AVERAGE	SITE 2 AVERAGE
Temperature		
2 m above		
surface		
30 cm below		
Precipitation		
pH*		

* For pH, state the prominent condition (e.g., if you got an alkaline reading 2 out of 3 times or 3 out of 3 times, record your site average as alkaline).

- b. Describe differences which you observed in the temperature measurements.
4. Have temperatures in the sites affected the type of plant life present?
5. Describe differences which you observed in the precipitation measurements.
6. Identify the relationship between precipitation and the amount of plant life.
7. Identify any differences in the pH measurements between the two sites.
8. Is the soil in each of the sites more acidic or basic?

As an extra, test the pH of any rain water you collect in your rain gauges. You can even test the pH of snow. Also test the pH of your tap water.

9. If you did not have a light meter, how could you tell one site had a greater light intensity than another?
10. One of the factors which affect light intensity is latitude. Can you identify four other factors which would affect light intensity?

Application

11. What is the ultimate source of energy for all living things?
12. Arrange the following statements in proper order (1-5) according to how biomes form.

_____ penetration of solar energy

_____ influences animal life in the site

_____ determines plant life in the site

_____ abiotic factors like temperature and moisture

_____ determines the type of biome
13. Identify two other abiotic factors which would influence the formation of a biome.
14. You are asked to determine the pH of a site where a certain species of plant is to be grown. This species of plant can only grow at a pH of 9.0 which is alkaline. The plant species will not survive in pHs of 8.0 or 11.0. You have at your disposal a pH meter which provides numerical measurements of pH. Why couldn't litmus paper be used in this situation?

Check your answers by turning to the Appendix, Section 2: Activity 1.

Part B

Collect data each day for ten consecutive days from two widely separated sites in Alberta by carefully listening to daily weather reports on radio or television. Record rainfall and daily high and low temperatures. Also collect relative humidity if this is reported. Select sites in two different Alberta biomes such as Banff or Jasper in the mountains and Lethbridge on the prairie grassland.

Make a table for your data and look for differences not only in the data as reported but also in the degree of change between sites. Read through Part A and try to answer as many questions as you can from Part A. You should be able to answer questions 1, 3, 4, 5, 10, 11, 12, 13, and 14. Check these answers in the Appendix.

The formation of biomes is not something which happens at random. It is an orderly process. Abiotic factors (matter and energy) play a major role in determining the type of biome. In the next activity you will examine the abiotic factors of another unit of the biosphere, an aquatic ecosystem.



ACTIVITY

2

Investigation of a Freshwater Ecosystem



Courtesy of D. Merrills

How important is water to you?

- Do you drink water or frozen fruit juices?
- Do you or members of your family grow plants?
- Do you eat freshwater fish?
- Do you have a favourite water hole where you swim, waterski, sail, or do some other water recreational activity?

How many of these points apply to you? These are some ways that freshwater ecosystems affect you.

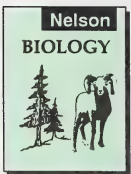
This activity will be similar to Activity 1 of this module except that you will be investigating a freshwater ecosystem rather than a terrestrial one. You will have to select a pond, lake, stream, or river. Ideally, in this investigation, you would compare two different sites. If you can't do this, sampling only one site will still be very interesting.

Investigation: What About Water?

Objective

Measure abiotic factors of temperature, pH, biochemical oxygen demand (B.O.D.), and hardness in an aquatic ecosystem. Keep in mind that this could be done in winter or summer. The tests you will perform are basic. More elaborate analysis is done by scientists studying water quality, especially in cases of suspected pollution. Water quality testing is also a big part of environmental assessment.

Background Information



Read the sections entitled Aquatic Communities and Characteristics of Standing Water on pages 68 and 69 of your text.

1. Identify the main difference between a marine community and a freshwater community.
2. Name three types of standing-water formations which can accumulate on land surfaces.
3. List four different types of running-water ecosystems.
4. Identify the difference between a lake and a pond with respect to light penetration.

PATHWAYS

If the time of year is appropriate, you are encouraged to do Part A.
If it is not possible, do Part B.

Part A

Materials

The following materials are needed to complete this investigation:

- thermometer
- 10 m of fishing line or string marked at metre intervals*
- 10 mL graduated cylinder
- medicine dropper
- pH paper with pH scale
- test tube
- small bottle of methylene blue
- test tube brush
- 250 mL beaker
- 250 mL flasks (4)
- stoppers for flasks
- hardness testing paper to determine dissolved mineral content
- tin foil (enough to wrap and cover the 250 mL flasks)*
- hardness scale
- * supplied by student

Procedure

If you decide to sample a lake or pond, you may compare some conditions at different depths. If you decide to sample standing water (lake or pond) and moving water (stream), you compare conditions at the same depth, for example, near the surface. Even sampling only one site is acceptable as you will still learn much about environmental sampling techniques. (You might consider using cold tap water as one sampling site.)

Caution: Before carrying out the various measurements, make sure you are familiar with the water you are working in. Can you swim? Wear a lifejacket if necessary. Take a friend along. Don't work alone. Get permission to go on private land. This investigation can be done in winter but be especially careful on ice. You might combine this investigation with a picnic or fishing trip. Be cautious with your glass ware, especially transporting to and from the site. Also remember to pick up any litter.



By now you should be familiar with how to construct a table for data. Make tables to record data about the following:

- **temperature** (at various depths on two different sites)
- **pH** (at the surface at one site or two different sites). **Note:** You will not be able to take samples of water from different depths in this investigation. This requires a more complex apparatus.
- **B.O.D.** (at the surface at one site or two different sites)
- **hardness** (at one site or at two different sites)

Temperature

At a lake or pond measure the water temperature at the surface (1-2 cm below the surface is okay), close to the bottom, and as near as you can find halfway in between. If the lake is deeper than ten meters you may need more line to lower the thermometer. When trying to find the temperature of deep water, let the thermometer remain several (3+) minutes at the desired depth. Then bring it rapidly to the surface. Read the thermometer immediately. This will minimize the change in temperature. Can you think of a better method?

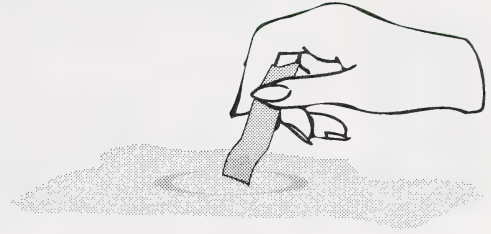
If measuring the temperature of water in a lake compared to a river, record temperatures found just below the surface. Note the air temperature during your investigation.



Courtesy of D. Merrills

pH

Measure pH using the pH paper in your lab kit. Dip the test paper about one centimetre into the water. Don't hold the paper strip in the water. Just dip it in and take it out immediately; pH values may not match the colours on the scale exactly so you may have to estimate, for example 6.5.

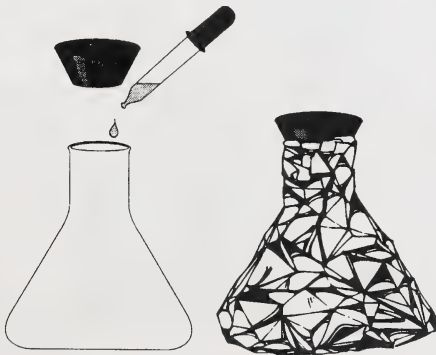


Biochemical Oxygen Demand (B.O.D.)

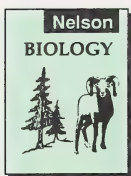
Biochemical oxygen demand (B.O.D.) is an indirect measurement of the amount of oxygen dissolved in water. Oxygen is needed to support respiration of living organisms. It comes from plant photosynthesis, diffusion from the atmosphere, and from physical entrapment. Physical entrapment of oxygen occurs when air bubbles are mixed in water such as in water falls, "bubbling brooks," and in water flowing through beaver dams.

Both respiration and bacterial decay reduce oxygen levels. Oxygen depletion is a serious problem in some Alberta lakes in the winter. Methylene blue indicator remains blue in the presence of oxygen but turns colourless when all the oxygen has been used up. If the colour disappears quickly, this indicates many organisms are using it up – high competition and not enough oxygen to go round. If the colour change is slow, there is plenty of oxygen and not much competition.

To find the B.O.D., water is placed in a flask with a little methylene blue. The sample is wrapped in aluminum foil or placed in the dark to prevent any photosynthesis. The flask must be completely full with no air bubbles. The time required for all the oxygen to be used up is measured.



Day	Colour
0	blue
1	
2	
3	
4	
5	



You'll have to briefly unwrap the flask each day to see if the blue colour has disappeared. To gain an appreciation for dissolved oxygen, read pages 71 to 75 in your text first.

- To measure the biochemical oxygen demand, add 1 mL of methylene blue to a flask using a measuring cylinder. Greater accuracy can be achieved by first finding 1 mL volume in a medicine dropper and then using the medicine dropper for the methylene blue reagent.
- Add 249 mL of sample water and stopper the flask. **Ensure that there are no air bubbles.** Basically, fill the flask with water and add the stopper. You'll probably spill a little water.
- Wrap the container in tin foil and place it in a dark area at room temperature ($\sim 20^{\circ}\text{C}$).
- Repeat procedure for a second sample of water if comparing pond to stream.
- Set up a control flask with tap water or deep well water.
- Check the samples twice the first day and once a day after that.
- Once any solution has turned colourless you will know that all of the oxygen has been used up.
- Use the following table to determine the percent of biochemical oxygen demand satisfied (higher percentage means higher oxygen content).

Days Needed for Colour to Disappear	Percent of B.O.D. Satisfied
0.5	11
1.0	21
2.0	37
3.0	50
4.0	60
5.0	68
6.0	75
7.0	80
8.0	84
9.0	87
10.0	90

High competition

Low competition

¹ GLC Publishers Limited, *Biology, A Canadian Laboratory Manual*, R. Ritter, B. Drysdale, D. Coombs, 1988.

- Record your data in an appropriate table.
- Remember to include the control sample on the table.

Observations

Site 1 Description: _____

Site 2 Description: _____

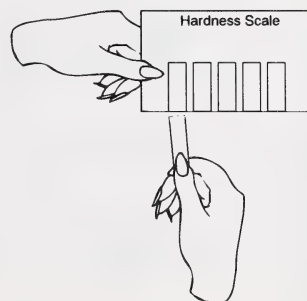
Hardness

ions – positively
or negatively
charged particles

Have you ever heard descriptions like “hard water” or “soft water”? Hard water is not ice! Hardness refers to minerals such as calcium and magnesium **ions** dissolved in water. Dissolved minerals affect water quality reducing the effectiveness of soaps and causing “scale” deposits in kettles, water heaters, and humidifiers. Many people in Alberta have home water softeners just to solve this problem. Iron, zinc, manganese, strontium, and other metallic ions can also increase hardness, but calcium and magnesium are the most common culprits.

To find hardness, dip a hardness test strip into the water. Don’t hold the strip in the water too long as the reagent in the paper will wash out. Just dip the paper in and take it out immediately.

Compare the test strip to the colours on the standard scale and record the results. Test the hardness of your tap water for comparison.



Hardness is generally calculated as equivalent to milligrams per litre of calcium carbonate dissolved in water.

mg/L CaCO_3

This means a sample with a result of 100 has the same hardness as if 100 mg of calcium carbonate dissolved in a litre of water. For interest, try the hardness test on other samples such as rain water or water from melted snow. Generally, 100 mg/L is average. More than 100 mg/L is hard water and less than 100 mg/L is soft water.

Analysis

5. How do the temperatures compare at the different sampling sites?
6. Compare the biochemical oxygen demand satisfied for each site.

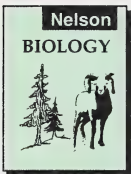
7. Is there a relationship between temperature and biochemical oxygen demand? Explain your answer.
8. Using the table of values for biochemical oxygen demand, plot the data using your own graph paper.
9. Describe the relationship illustrated by the graph.
10. Identify three possible errors in your investigation.

Application

11. Based on the results obtained in this investigation, would you expect the same types of organisms to live in the two sites you studied? Explain your answer.

Check your answers by turning to the Appendix, Section 2: Activity 2.

Part B



12. Read pages 68 to 70 in your text and answer Review Questions 1 to 5 on page 71.
13. Make a table comparing oligotrophic lakes to eutrophic lakes. Compare factors of depth, temperature, and nutrient levels. Do you know of any oligotrophic or eutrophic lakes in your area?
14. Read pages 71 to 75 in your text and answer Review Questions 8 to 16 on page 75.

Follow the Investigation in Part A to perform a temperature, pH, B.O.D., and hardness test on cold tap water where you live. Try to answer the Analysis questions in Part A; check the answers in the Appendix if you have difficulty.

In this activity you have investigated the abiotic factors of a freshwater ecosystem. In the next activity you will examine the impact humans have had on abiotic factors.

DID YOU KNOW?

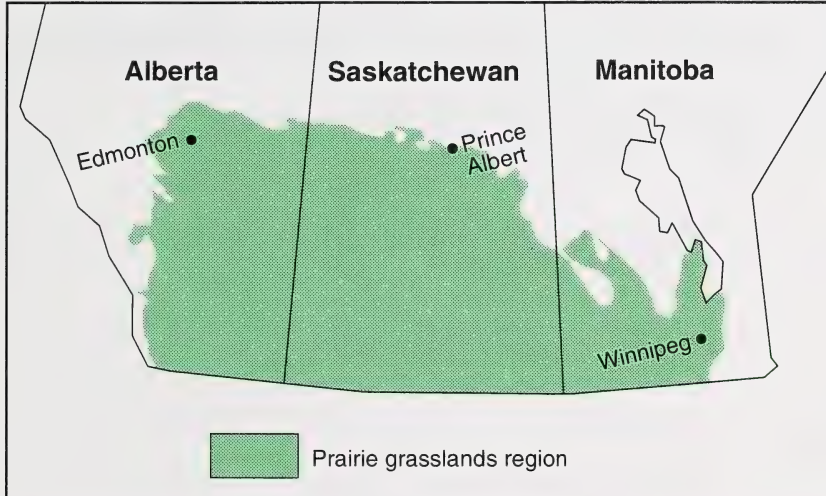
Three percent of the Earth's water is fresh water. Approximately 98% of this fresh water is frozen in the icecaps of Antarctica and Greenland. The remaining 2% makes up freshwater ecosystems.

ACTIVITY

3

The Endangered Grasslands

In this activity you will examine how humans have altered the abiotic factors in the prairie grasslands region. Read the following and then answer the questions that follow.



The Prairie Grasslands Region

The prairie grasslands region, also known as the prairie ecozone, is one of the most human-altered regions in Canada. Two of its native ecosystems, tall-grass prairie and plains fescue, have been almost eliminated. Less than 5% of the prairie grasslands region is protected at present.

Agriculture has produced the most drastic and extensive alteration of the prairies. About 87% of the prairie grasslands region is farmland, and about 44% is cropland.

The shift from grassland to grain cultivation on the prairies tends to increase losses of soil organic matter and plant nutrients; it is estimated that the original organic matter levels in prairie soils have been reduced 40-50%.

Prairie wetlands provide critical habitat for more than 50% of North America's waterfowl.

Relative to its area and population, the prairie ecozone is the native habitat of a disproportionate number of threatened and endangered species of Canadian wildlife.

The natural water systems have been extensively modified and intensively developed; reservoirs – for hydro and thermal power generation, irrigation projects, flood protection, and water management – have been developed on virtually every major river system in the grasslands region.

Although only about 2.4% of farmland is irrigated, irrigation accounts for 46% of water withdrawal; irrigation also accounts for 69% of total water consumption in the Prairie provinces.

Water quality is not getting significantly worse in most respects but is close to a minimal level at many locations, and current economic, social, and climatic

trends may cause it to drop to an unacceptable level.

Economic development is at the limit of available water supplies in some basins in the Prairie provinces, and there are growing concerns in southern Alberta and Saskatchewan that increasing consumptive uses will prevent in-stream requirements of aquatic ecosystems from being met.¹

1. Which provinces contain prairie grasslands?
2. Where in the provinces are the grasslands located?
3. Identify two native ecosystems of the prairie grasslands which have been almost eliminated.
4. Explain how humans have influenced each of the following factors and how each contribute to the loss of the prairie grasslands.

urbanization –
the formation of
towns and cities

a. agriculture

c. irrigation

e. **urbanization**

b. natural water systems

d. water levels

Check your answers by turning to the Appendix, Section 2: Activity 3.

Isn't it interesting that the human species has done so much to improve life on the planet and now risks possible destruction because of its own altering of the natural balance between matter and energy? The human race is at a turning point – either it continues to abuse the environment and chances extinction or it tries to save the planet by becoming active in restoring the natural state of the environment.

Follow-up Activities

If you had difficulty understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

¹ Reproduced from the Government of Canada, 1991, *The State of Canada's Environment*, 1991, pg. 17-1 and 17-5. Reproduced with permission of the Minister of Supply and Services Canada, 1993.

Extra Help

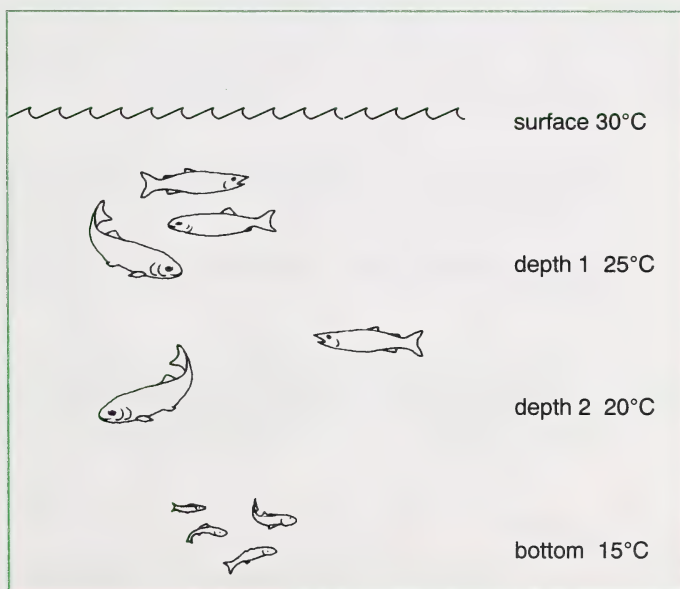
Do the following questions to review important concepts from Section 2.

1. Examine the following table.

ABIOTIC FACTORS	PLANET A	PLANET B
average temperature °C	-10 to -20	20 to 30
precipitation	snow year round	50 to 70 cm/y
plant life	very little	abundant
animal life	a few small rodents	abundance of animal life

Suppose you had just travelled into space and had the choice of living on Planet A or Planet B for the rest of your life. You are required to “live off the land.” Which area would you choose? Explain your answer.

2. On a particular day the temperatures in the following diagram were recorded at the various depths in a lake.



Optimum temperatures for three common species of fish are 15°C for trout, 24°C for perch, and 32°C for carp.

- a. Make a table to illustrate the data. Use the headings provided.

FISH	OPTIMUM TEMP. (°C)	PREFERRED DEPTH
------	--------------------	-----------------

- b. Construct a bar graph of the data showing the type of fish and its preferred depth.
- c. Identify the primary abiotic factor which determines the preferred depth of each fish. Can you think of a biotic factor?
3. Now examine what would happen if hot water from an industrial plant were allowed to flow into the stream. This would raise the temperature of the stream by 10°C at all depths.

Note: An increase of 5°C above the optimum can be deadly to a fish.

- a. The new temperatures for the various depths are as follows:

surface —> _____

depth 1 —> _____

depth 2 —> _____

bottom —> _____

- b. Describe the actions of the different species of fish due to this industrial pollution.
- c. Who was responsible for causing the above actions by the different species of fish?

Check your answers by turning to the Appendix, Section 2: Extra Help.

Enrichment

Do one of the following activities.

1. If you have access to a light meter, use it to investigate the abiotic factor of light intensity. Different areas in a terrestrial ecosystem can be tested.

germination –
sprouting of a
plant from a seed

2. Carry out an experiment to study the effects of light intensity on **germination** in pea plants.

Materials

- 15 pea seeds
- 3 planting boxes
- potting soil
- 3 thermometers

Procedure

- Plant five seeds in each planting box.
 - Place one box in direct sunlight.
 - Place the second box in indirect sunlight.
 - Place the third box in a dark area.
 - Water the plants at the same time of day and use the same quantity of water.
 - Carefully place a thermometer in the soil in each box.
 - All variables should be held constant except for the light intensity.
 - Record how long it takes for the seeds in the different light intensities to germinate.
 - Note the temperature of the soil at various times during the day.
3. If you have access to a Hach oxygen test kit you can measure the amount of dissolved oxygen in different water samples.
 4. Do some research on your drinking water. Does it come from surface waters (river, lake, stream) or from an underground well? How is the water purified or treated? What chemicals are used to treat the water? What is the hardness and pH of the water?
 5. Do some research on how your drinking water is exposed to different types of pollution. Find out the effects of this type of pollution.
 6. Do a group project which will involve an oral presentation about all of the human factors involved with affecting the natural abiotic state of terrestrial and aquatic ecosystems.
 7. Using sources available to you, identify functions for the following:
 - a. hygrometer
 - b. anemometer
 - c. Secchi's disk

Check your answers by turning to the Appendix, Section 2: Enrichment.

Conclusion

Abiotic factors? Temperature? Wind? Water? Oxygen? Are they that important? You'd better believe it! These factors, though nonliving components, play a vital role in the biosphere. Combinations of these factors control plant and animal life in various parts of the world. The biosphere is affected, too, by the influence of the human species.

In this section you studied some of the abiotic factors in terrestrial and aquatic ecosystems. You also briefly looked at the potential for human impact. This is still very much just a beginning of your studies of humans and the biosphere. In the next section you will add to your knowledge the biotic factors.

25

Section 2 Assignment: Abiotic Factors in Ecosystems

Review the Evaluation information found in the introductory pages of this module.

It is important to number and clearly identify each page with the following information at the top:

Biology 20 – Module 2 Section 2 Assignment Page # Name and ID #

Be sure to write legibly. Leave a wide left margin and number all of your pages.

- The following table provides a number of abiotic factors in three sites: a forest, a grassland, and an ecotone. (10 marks)

ABIOTIC FACTOR	SITE 1	SITE 2	SITE 3
Temperature maximum/ minimum	27°C/12°C	24°C/15°C	30°C/10°C
Relative humidity	75%	90%	70%
Evaporation rate	42 mL/day	15 mL/day	50 mL/day
Wind velocity	8 km/h	0 km/h	17 km/h
Light (percent of open field)	30%	4%	100%
Soil pH	6.8	6.0 – 6.6	6.9

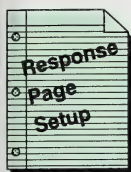
- Which site is the ecotone? Explain your answer using data from the table.
- Which site would you identify as the forest region? Support your answer using two types of data from the table.
- Identify two variables which should have been controlled when this data was collected.

2. Why is it better to take a number of measurements and calculate an average rather than simply taking one measurement? Explain your answer. (2 marks)
3. Use the following data to plot a graph of depth versus temperature. Note the range of values and set up your graph so most of the space is used. (8 marks)

a.

DEPTH (m)	DISSOLVED OXYGEN (ppm)	TEMPERATURE (°C)
0	8	19.4
1.5	—	19.4
3.0	8	19.2
4.5	—	19.2
6.0	9	18.9
7.5	—	18.9
9.0	7	18.3
10.5	—	16.7
12.0	9	13.3
14.0	—	11.7
15.0	8	10.6
17.0	—	10.0
18.0	8	9.4
21.0	8	9.4
25.0	8	9.4
27.5	6	8.9
30.5	6	8.3
33.5	6	8.3
36.5	3	7.8

- b. Describe the relationship between depth and temperature based on your graph.
- c. At what depth(s) is there the greatest concentration of dissolved oxygen?
- d. As the depth increases after 12.0 m, what happens to the dissolved oxygen level?
4. Describe three possible actions which can be done to prevent or slow down the loss of the grassland biome. (3 marks)
5. Which biome will replace the grassland biome if it becomes extinct? Describe the abiotic factor which will be mainly the cause for this change in biomes? (2 marks)



SECTION

3

Biotic Factors in Ecosystems



How many biotic factors can you identify in this photograph? Which organisms are not visible but which you assume are there? Are all biotic factors animal or plant?

By now you are probably quite familiar with biotic and abiotic factors and can recognize many of these in nature. You are on your way to becoming a scientist.

In this section you will learn to critically examine the biotic factors present in a terrestrial and an aquatic ecosystem. You will also look at the role of decomposers in an ecosystem, and you will continue to study the impact of humans.

Keep in mind that you began studying from a very broad viewpoint – the biomes – and are moving to more specific, narrower factors. Remember that the environment as a whole consists of many parts and even small changes can have large effects.

ACTIVITY

1

Aquatic Factors



"Gee Dad, if we had just gone straight to Banff, we'd be so busy looking at all those mountains we wouldn't have noticed all this nature!"

Stop and smell the water lilies! In this activity you are going to investigate the life of a freshwater pond or lake.

In your text read page 71 on The Structure of Lakes and Ponds. Pay particular attention to the different zones found in a pond or lake. Then answer the next two questions.

- Using the following table, compare the different zones with respect to depth, temperature, and light.

ZONE	DEPTH	TEMPERATURE	LIGHT
Littoral			
Limnetic			
Profundal			
Benthos			

- Define the term *plankton*.

Check your answers by turning to the Appendix, Section 3: Activity 1.

Nelson
BIOLOGY



Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☒ C. Organizing
- ☐ D. Analysing
- ☐ E. Synthesizing
- ☐ F. Evaluating

These are the classification zones for any body of water made on the basis of abiotic components. The next investigation will look at the living species or biotic components in an aquatic ecosystem.

Science Skills

☐ A. Initiating

☒ B. Collecting

☒ C. Organizing

☒ D. Analysing

☐ E. Synthesizing

☐ F. Evaluating

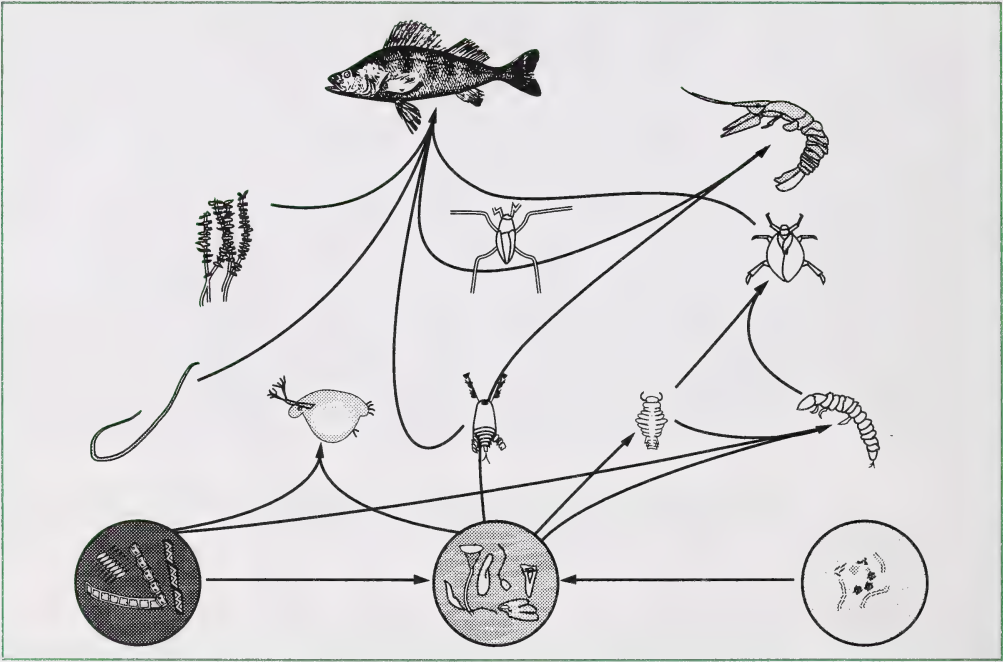
Investigation: Biotic Factors of a Pond

Objective

Study the biotic factors of a standing freshwater ecosystem.

Background Information

In studying the biotic factors, you will be observing different groups of living material. The following diagram should help you.



PATHWAYS

You are encouraged to do Part A. If it's not possible, do Part B.

Part A

Materials

- bucket*
- rubber boots and rubber gloves*
- compound microscope (if available)*
- 5 collecting jars (assorted sizes for collecting specimens)*
- a field guide of trees and shrubs of Alberta (if possible) – can be obtained from Alberta Fish and Wildlife*
- notepad and pencil*
- dip net
- hand lens

* supplied by student

Procedure

The selection of a suitable site will be important for the success of this investigation. Basically you need a pond which is easily accessible. The depth of the water should be a couple of metres in some regions.



Caution: Before carrying out the investigation, make sure you are familiar with the waters you are working in. Wear a life jacket if necessary. Take a friend along to work with you. Don't work alone. Make sure you get permission from the proper authorities to do your study in your selected area. Be careful not to damage vegetation or disturb wildlife.

Before entering the water, take a good look around the body of water. Identify trees and other vegetation using field guides as well as your own knowledge. Are there any animals visible in the region? Stay quiet. You'll see more.

- Sketch the shape of the pond, labelling general vegetation and indicate north if possible.
- Record the major species of **emergent**, **submergent**, and floating plants. Estimate the quantity of each species as being abundant (**A**), common (**C**), occasional (**O**), or rare (**R**). Make tables similar to those under Observations to record your data.
- Take samples of organisms at various depths using a dip net. Identify as many animals as possible on site and estimate the quantity of each as you did for the plants. Take sample containers back for microscopic viewing if equipment is available. Otherwise, return all organisms to the pond.
- Record and identify other small animals in the area such as rodents and birds.

emergent – aquatic plants that grow above the surface, like cattails

submergent – aquatic plants that grow totally under water

The following diagrams are included to help you identify some plants and animals.

COMMON POND PLANTS

Plants found in the
water near the shore



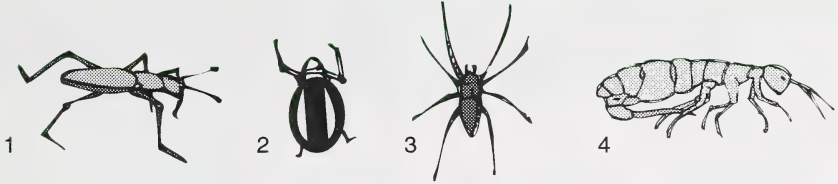
Plants found on and
under the water



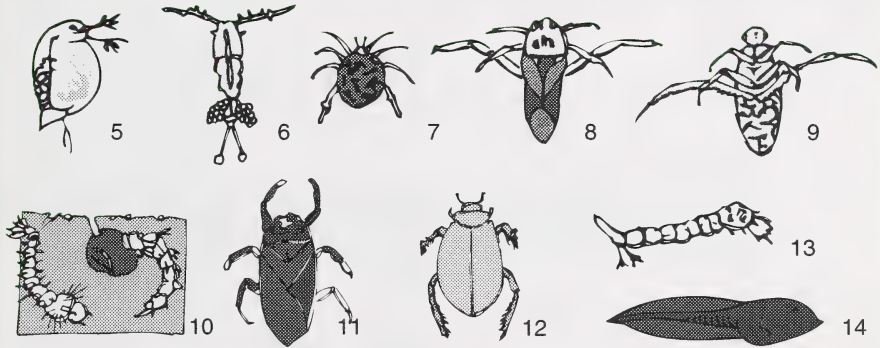
- | | | | | | |
|---|---------|----|-------------|----|---------------|
| 1 | Cattail | 6 | Pondweeds | 11 | Water Milfoil |
| 2 | Burreed | 7 | Hornwort | 12 | Waterweed |
| 3 | Bulrush | 8 | Bladderwort | 13 | Tape Grass |
| 4 | Reed | 9 | Duckweeds | 14 | Buttercup |
| 5 | Sedge | 10 | Cabomba | 15 | Water Clover |

LARGER POND ANIMALS

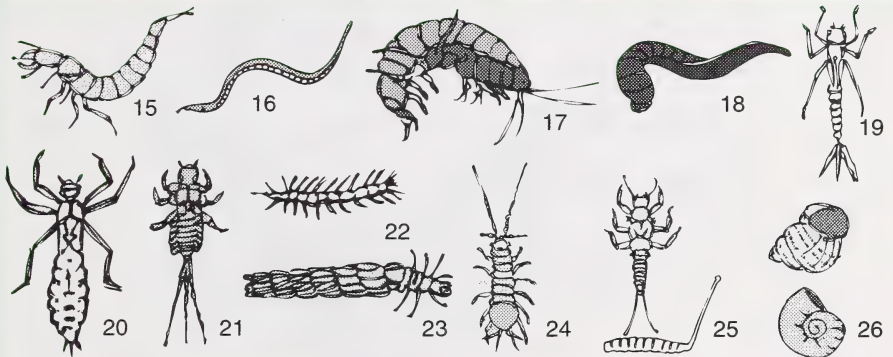
Found on
the surface



Found between
surface and bottom



Found on bottom -
in mud or on plants



- | | | |
|------------------------|-------------------------------|---------------------------|
| 1 Water Strider | 10 Mosquito Larva and Pupa | 19 Damselfly Nymph |
| 2 Whirligig Beetle | 11 Giant Water Bug | 20 Dragonfly Nymph |
| 3 Water Spider | 12 Diving Beetle | 21 Mayfly Nymph |
| 4 Springtail | 13 Midgefly Larva (bloodworm) | 22 Whirligig Beetle Larva |
| 5 Daphnia (water flea) | 14 Tadpole | 23 Caddis Fly Larva |
| 6 Cyclops (water flea) | 15 Diving Beetle Larva | 24 Sowbug |
| 7 Water Mite | 16 Nematode | 25 Stone Fly |
| 8 Water Boatman | 17 Scud | 26 Snails |
| 9 Backswimmer | 18 Leech | |

Observations

Make tables similar to the following examples to record your observations.

Science Skills

☐ A. Initiating

☒ B. Collecting

☒ C. Organizing

☒ D. Analysing

☐ E. Synthesizing

☐ F. Evaluating

TABLE 2.11: Trees and Shrubs Around the Body of Water

PLANT SPECIES	ABUNDANCE (A, C, O, R)

TABLE 2.12: Animal Life Around the Body of Water

ANIMAL SPECIES	ABUNDANCE (A, C, O, R)

TABLE 2.13: Floating, Emergent, and Submergent Plants

PLANT SPECIES	ABUNDANCE (A, C, O, R)

TABLE 2.14: Animals (visible to the naked eye)

ANIMAL SPECIES	ABUNDANCE (A, C, O, R)

Analysis and Interpretation

3. Did you find different species in different areas of the ecosystem? What abiotic factors might contribute to this?
4. Identify three producers in the ecosystem you studied.
5. Identify three consumers in the ecosystem you studied.
6.

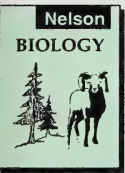
a. Would you expect decomposers to be present in the ecosystem? Explain your answer.

b. Describe any evidence of decomposers that you observed.

7. If you were to compare the abundance of plant species with animal species, which one would be more numerous? Use data from the investigation to support your answer.

Check your answers by turning to the Appendix, Section 3: Activity 1.

Part B



Use Figure 2.4 on page 46, Figure 2.6 on page 48, and Figure 2.8 on page 50 in your text. Read through the Procedure in Part A and notice the organized method of investigating the ecosystem. Now try to answer questions 3 to 7 in Part A. The text figures show various biotic components of aquatic ecosystems. Check the answers in the Appendix for more interpretation.

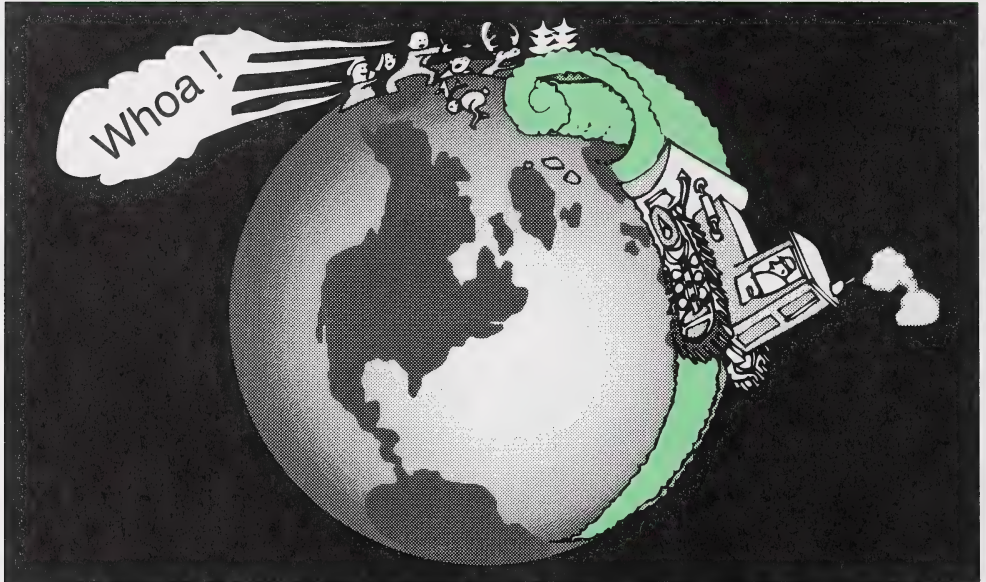


After investigating a standing freshwater ecosystem, it should be obvious to you that there is a lot of activity in a pond. Relationships exist between the plants and animals. Animals have relationships with other animals. They are all linked together by a common need for matter and energy. Take note that while you may have studied a standing-freshwater ecosystem, similar biotic relationships exist in flowing water and in marine ecosystems. The wide variety of living things that make up the biotic factors in any ecosystem create biological diversity. This is further explored in the next activity.

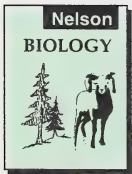
ACTIVITY

2

Biological Diversity



Biological diversity refers to the variety and variability that exist among living organisms. In the ecosystems that you have studied, biological diversity is easy to see. There were many different kinds of plants and animals. Diversity is important for a healthy ecosystem. If the interdependency of organisms is widely spread amongst many different types, then the effect of one organism disappearing will be small.



herbicide –
chemical that is
toxic to plants

Look at Figure 2.8 on page 50 in your text. This is a simplified food web but it also shows biological diversity. Now, imagine if a **herbicide** destroyed the herb in this food web. Could the animals eat something else? Certainly, grasses, buds, twigs, and leaves could be substituted and most members of the ecosystem would survive. However there are limits. What if all the plants in Figure 2.8 were destroyed?

Unnatural Diversity

Human activities have had a major impact on biological diversity in the world. The following table provides a summary of biological diversity in Canada and identifies reasons for reduced biological diversity.

SUMMARY OF THE BIOLOGICAL DIVERSITY OF WILD SPECIES IN CANADA			
Plant and animal groups	Known species ^a	Suspected species ^a	Principal pressures/stresses
Algae and diatoms	5 323	2 800	Water pollution
Slime molds, fungi, and lichens	11 400	3 600	Atmospheric pollution
Mosses and liverworts	965	50	Habitat reduction, especially deforestation and loss of wetlands
Ferns and fern allies	141	15	Habitat reduction
Vascular plants (about 78% native)	4 187 ^b	100	Habitat reduction
Molluscs	1 121	100	Water quality changes
Crustaceans	3 008	1 100	Overharvesting, water pollution
Insects	33 755	32 800	Habitat change, biocides
Spiders, mites, and ticks	3 171	7 700	Habitat change, biocides
Other invertebrates	6 879	5 000	Habitat change, biocides
Sharks, bony fish, and lampreys	1 091	513	Habitat destruction, water pollution, overharvesting
Amphibians and reptiles	83	2	Habitat destruction, acid precipitation, overharvesting
Birds	578	0	Habitat change and loss, biocides, competition from nonnative species, hunting
Mammals (excluding humans)	193	0	Habitat change and loss, hunting
Total	71 895	53 780	
^a“Known species” are those that have already been named and described, whereas “suspected species” are those that are estimated to exist but have not been named or described. Bacteria and viruses also contribute part of Canada’s biological diversity. Almost 170 000 species are suspected to exist in the country, but only about 2 200 species have ever been named. ^bOf the species total for vascular plants, 3 269 are considered native species and 918 are introduced or nonnative. Source: Condensed from Mosquin (1990).			

¹ Produced from the Government of Canada, 1991, *The State of Canada's Environment*, 1991, pg. 6-5. Reproduced with permission of the Minister of Supply and Services Canada, 1993.

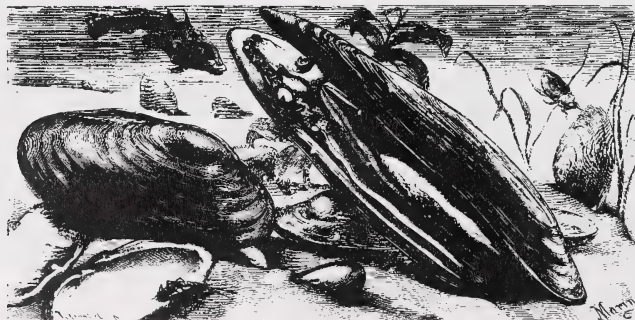
1. The major pressures humans have put on biological diversity are listed here. Match the term on the left side with the phrases on the right by making a table.

Human Activity	Source of Pressure
• Agriculture	• industrial manufacturing processes, pesticides, fertilizers
• Forestry	• fossil fuels combustion and removal of forests contribute to the greenhouse effect
• Acid rain	• industrial pollution causing major damage to aquatic ecosystems
• Toxic contaminants	• bringing in of species which may be diseased or that compete with native species
• Introduced species	• clearing of forests, draining wetlands, cattle grazing, use of herbicides and pesticides
• Climatic change	• logging, logging roads, hydroelectric lines

Did you notice that some of the activities involved several different sources of pressure?

2. Compose a definition for biological diversity.
3. Describe the relationship between biological diversity and a healthy ecosystem?
4. Suggest four ways the human species has negatively affected biological diversity.
5. Identify two ways these negative pressures by humans affect biological diversity?

Putting in new species can be as bad as taking species out. Look at the following example of the impact of a new species into an aquatic ecosystem.



Zebra mussel: invader of a different stripe

Small but mighty, the zebra mussel is infiltrating the waterways of North America. Native to the Black and Caspian seas, this fingernail-size, yellow-and-brown-striped mollusc can now be found in all of the Great Lakes as well as the St. Lawrence River.

Finding a niche in an already disturbed ecosystem, the prolific mollusc has undergone a population explosion. In western Lake Erie, an ideal warm-water habitat rich in algae (for food) and calcium (for shell growth), densities of 700 000 per cubic metre have been found. In other lakes, the absence of these ideal conditions will limit distribution and growth, and such extreme densities are unlikely.

Under the right (or wrong) conditions, zebra mussels attach to and encrust all hard surfaces, including water intake pipes and rocky, fish spawning shoals. Their effect can be devastating, economically and ecologically. Preliminary research results concerning impacts on fish spawning shoals are more favourable than at first anticipated, but it is still too early to be optimistic.

As they are filter feeders, zebra mussels affect the overall aquatic ecology. They remove phytoplankton

from the water, which ultimately affects walleye, trout, bass, and perch and fish-eaters at the top of the food chain. Some waterfowl, such as scaup, have discovered the new abundant food source and delay their migration, feasting on zebra mussels. Unfortunately, there are not enough natural predators, such as diving ducks and some fish, to limit the population growth of the pests. The hope is that the zebra mussel population will collapse to and stabilize at a lower level.

Mussel shells can severely restrict water flow, and already they are impairing municipal water supply, agricultural irrigation, and electrical generating plants. Costs of remedial measures, such as chlorination treatment to kill larvae and relocation and redesign of water intakes to deeper water, may exceed hundreds of millions of dollars.

Even so, the zebra mussel is in the Great Lakes to stay. Treatment of ballast by chemicals or heat and mandatory replacement of ballast (a voluntary regime now exists) are under consideration as means of preventing the introduction of other exotic species.¹

6. Identify three harmful ecological effects of the zebra mussel.

Check your answers by turning to the Appendix, Section 3: Activity 2.

Can you think of any other introduced species that has had a negative effect on an ecosystem?

¹ Produced from the Government of Canada, 1991, *The State of Canada's Environment*, 1991, pg. 18-24. Reproduced with permission of the Minister of Supply and Services Canada, 1993.

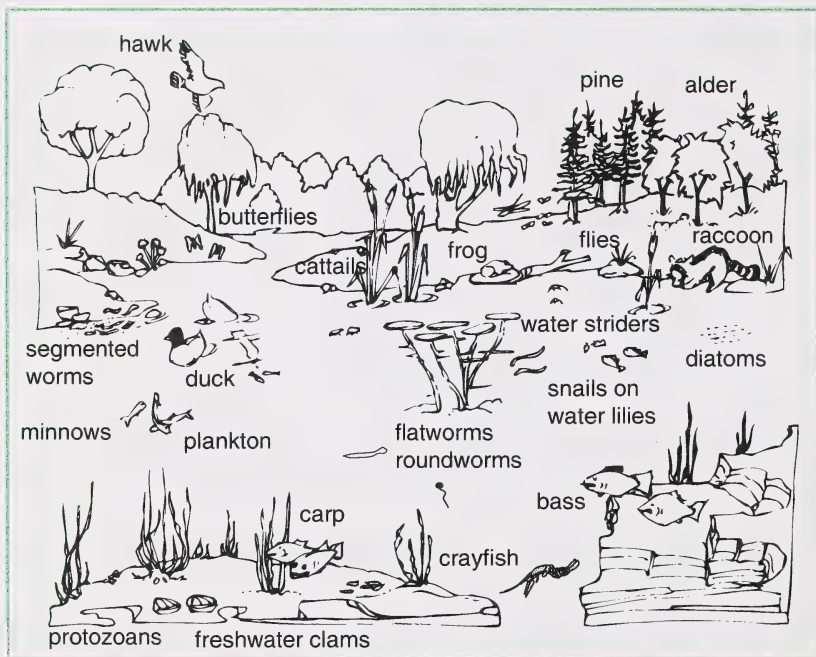
Follow-up Activities

If you had difficulty understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

Do the following questions to review important concepts from Section 3.

1. Examine the following diagram.



- a. Identify the five plants in the ecosystem.
- b. Identify the ten animals in the ecosystem.
- c. Which are the decomposers in the ecosystem? If decomposers were not present in the ecosystem, what would happen to dead plants and animals?
- d. The animals, plants, and decomposers in an ecosystem make up the _____ components of the ecosystem.

- e. If you were to count the decomposers, animal species, and plant species in this ecosystem, approximately how many different species would there be?
 - f. Would you expect to find a large variety or little variety of species in a healthy ecosystem?
2. In a small ecosystem, it is observed that Species A only eats grass for food.
 - a. Identify the producer and consumer in this ecosystem.
 - b. Would you expect there to be more of Species A or more grass in this ecosystem? Explain your answer.
 3. Imagine you are an animal who lives on an isolated island. Your diet consists of berries and you live in trees. A person moves into your "space" and begins clearing the land for agricultural purposes. Eventually the entire island will be cleared of trees, and berries will be nonexistent. What is your fate? Explain your answer.

Check your answers by turning to the Appendix, Section 3: Extra Help.

Enrichment

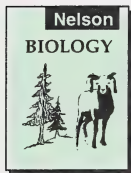
Do one or more of the following activities.

1. Set up a terrarium by transferring plants and animals from a particular area near where you live. A large jar or aquarium may be used. Daily observations can be made.
2. Do a field study of the plants in a terrestrial ecosystem. Field guides characteristic of the area are necessary for this study. Field guides on trees and shrubs, aquatic plants, and flowers are available from the Alberta Fish and Wildlife Division.

Alberta Fish and Wildlife Division
Publications Department
9945 - 108 St.
Edmonton, Alberta
T5K 2G6

3. Set up an aquatic ecosystem in an aquarium. Study the relationships between the biotic components over a period of time.

4. Carry out an investigation, similar to the one done in Activity 2, except use a running-water ecosystem for the site of study. Compare your findings with a standing-water ecosystem.
5. Contact Alberta Fish and Wildlife and obtain publications on *Alberta's Threatened Wildlife*. They have individual publications on endangered species in the province.
6. If the equipment is available, do the investigation in your text on page 76 on acid rain.



Check your answers by turning to the Appendix, Section 3: Enrichment.

Conclusion

The photographs of the terrestrial and aquatic ecosystem at the beginning of the section showed two very different areas. However, even though the species differed, there were common points between the two. They both exhibit a variety of species and the numbers of each differ. The numbers relationship will become more familiar to you in the next module. The human species has had a major impact on various wildlife species. Again, humans have created the problem and will also have to solve it. A step in the right direction is creating awareness of threatened species and attempting to reverse the trend towards extinction.

25

Section 3 Assignment: Biotic Factors in Ecosystems

Review the Evaluation information found in the introductory pages of this module.

It is important to number and clearly identify each page with the following information at the top:

Biology 20 – Module 2 Section 3 Assignment Page # Name and ID #

Be sure to write legibly. Leave a wide left margin and number all of your pages.

1. Use the following diagram on "The Grasslands" to answer the next questions.
(10 marks)

- a. Identify and describe five abiotic factors that contribute to the formation and maintenance of this biome. Include in your description what is specific about this factor in this biome, for example deep and long-lasting snow covers.
- b. Identify five biotic factors found in this biome.



ALBERTA RECREATION AND PARKS

2. Identify six species of plankton found in a standing fresh-water ecosystem. **(3 marks)**
3. Identify two species from each of the following zones: **(3 marks)**
 - a. littoral
 - b. on the surface
 - c. benthos
4. Describe two ways biotic factors can differ from one ecosystem to another. **(4 marks)**
5. Briefly describe two factors which will enhance biological diversity in an ecosystem. **(2 marks)**
6. List three ways the human species has reduced biological diversity in ecosystems and briefly explain how each way has had an affect. **(3 marks)**

Snow Ecology



Courtesy of D. Merrills

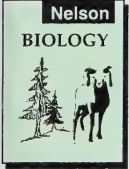
How do you feel when you see the first snowfall of the year? Do you welcome it with open arms or does it make you feel gloomy? What types of adaptations do you make for the winter season? The winter coat and boots come out of the storage closet. You may try a little harder to get a ride in a nice warm vehicle as opposed to walking. If you have your own vehicle, it means leaving a few minutes early to get to your destination and driving with a little more care. How do animals adapt to the winter season, to the cold, to the dark, and to the snow?

In this section you will investigate some of the abiotic characteristics of snow. You will also consider the change in biotic factors as a result of snow. In addition you will become familiar with the interaction between abiotic and biotic factors during the winter season.

ACTIVITY

1 Snow, Snow, Snow

In this activity you will investigate the abiotic characteristics of snow. However, before you do this, you will need some background information. Read pages 77 and 78 in your text on Winter in Northern Ecosystems.



Courtesy of D. Merrills

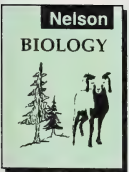
1. Describe five common types of snow according to the Inuit.

Read pages 85-87 in your text entitled Snow Ecology: Abiotic Factors.

2. Snow makes an excellent insulator. What does this mean and what type of snow is the best insulator?

Try the demonstration on page 85 of your text involving metal, wood, and Styrofoam. It will give you a better understanding of insulation and conduction.

3. Why do woollen socks lose their insulating value when they become wet?
4. In a **snow pack**, where is the temperature the warmest? Where is it the coldest? Explain your answers.



snow pack –
total layer of
snow from
ground to snow
surface



5. How could studying a core of snow provide advance warning of an avalanche?

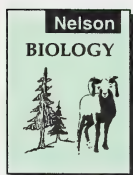
pukak layer – an open area between the snow pack and the ground

6. How does the **pukak layer** form in a snow pack?

7. Of what importance is the pukak layer to animals?

8. When the snow pack reaches a depth of about 30 cm, what may be the temperature of the pukak layer?

Hint: Check Figure 3.31 on page 91 in your text.



Investigation: Abiotic Characteristics of Snow

Objectives

Examine the effects of snow cover on temperature.

PATHWAYS

You are encouraged to do Part A. If this is not possible, do Part B.

Background Information

This investigation is best done on the coldest day possible and where a site of undisturbed snow pack is as deep as possible. You will be outside for a while so dress appropriately. Read through the entire investigation before going out so you know what you'll be doing. Use the thermometer and hand lens from your lab kit. All other materials will have to be supplied by yourself. Compare two sites if possible. If not possible, sample just one site and adjust your observations.



Science Skills

- ☐ A. Initiating
- ☒ B. Collecting
- ☒ C. Organizing
- ☒ D. Analysing
- ☐ E. Synthesizing
- ☐ F. Evaluating

Part A

Do the investigation on Abiotic Characteristics of Snow on page 93 of your text.

Observations

9. Do textbook question 2a under Procedure on page 93 of your text.
10. Do textbook question 3b under Procedure on page 93 of your text.
11. Do textbook question 5c under Procedure on page 93 of your text.
12. Do textbook question 5d under Procedure on page 93 of your text.
13. Do textbook question 7 under Procedure on page 93 of your text. Use the following table.

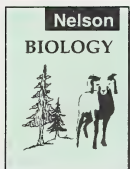
	SITE 1 (°C)	SITE 2 (°C)
Snow Depth		
Snow Surface Temperature		
Midpoint Temperature		
Snow – Ground Temperature		

14. Do textbook question 8e under Procedure on page 93 of your text.
15. Do textbook question 11f under Procedure on page 93 of your text.

Check your answers by turning to the Appendix, Section 4: Activity 1.

Science Skills

- ☐ A. Initiating
☐ B. Collecting
☒ C. Organizing
☐ D. Analysing
☐ E. Synthesizing
☐ F. Evaluating



Part B

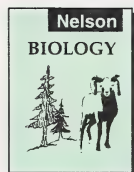
Use Figure 3.23 on page 86 in your text as a field sample. Assume the snow pack in the figure is one metre deep. Use the information from the chart that follows to answer questions 9 to 15 in Part A.

SNOW CRYSTAL	TEMPERATURE (°C)
1	- 21
2	- 13
3	- 11
4	- 9

Check your answers by turning to the Appendix, Section 4: Activity 1.

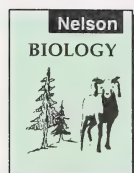
Before doing this activity, did you know there were different kinds of snow? Did you realize there could be different layers in a snow pack with different temperatures? These characteristics are particular abiotic factors in snow ecosystems dependent upon energy. These abiotic factors greatly influence the characteristics of biotic factors, that is, the type of living organisms in the same ecosystem. Snow can be really interesting if you stop and take a careful look at it.

Check Applying the Concepts, number 10 and Critical-Thinking Questions, number 5 on page 95 in your text for further considerations.



ACTIVITY

2 How Winter Affects Biotic Factors



How do animals cope with the winter season? Turn to pages 78 to 85 in your text and read the sections on Adaptations for Winter and Response to Snow to find out.

1. Define the following terms:

- chionophobes
- chioneuphores
- chionophiles

2. Identify each organism listed in the following table as a chionophobe, chioneuphore, or chionophile and state the way it responds to the winter season.

ANIMAL	CHIONOPHOBE/ CHIONEUPHORE/ CHIONOPHILE	RESPONSE TO WINTER
barren-land caribou		
chipmunk		
Bracon cephi		
wood frog		
elk		
snowshoe hare		
ruffed grouse		
arctic fox		
musk-ox		

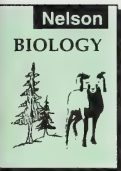
3. Describe countercurrent heat exchange. Explain what purpose it serves in chionophiles.

Now, it's time to take a closer look at the small animals that live under the snow.

Read pages 88 to 91 in your text on Snow Ecology: The Biotic Community and The Subnivean Ecosystem.

- List three factors which make life under the snow advantageous for animals living in a subnivean environment.
- Take a look at the graph located on page 88. Describe the relationship between the two variables involved.
- Identify two ways in which coniferous trees adapt to the winter snow.
- What are the three critical periods for subnivean mammals? Explain why each of these may be critical times for these animals.

Check your answers by turning to the Appendix, Section 4: Activity 2.



Isn't it interesting that there is an abundance of animal activity going on in the winter months? Not all animals hibernate. Animals adapt to the snow conditions and are able to survive using some very intriguing methods such as freezing themselves, supercooling, and living under the snow.

Follow-up Activities

If you had difficulty understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

Do the following questions to review important concepts from Section 4.

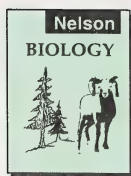
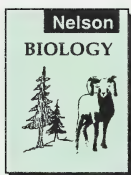
1. As you move vertically up a snow pack, the temperature _____ and the density of the snow _____. (Check Figure 3.23 on page 86 and Figure 3.25 on page 87 in your text.)
2. As you move vertically up a snow pack or the snow pack decreases in height, the insulation properties _____.
3. Animals can do a number of things when the winter snow arrives. Unscramble the following terms to see how some animals respond.
 - a. teramgi
 - b. bntearhei
 - c. erfeze
 - d. padat

Check your answers by turning to the Appendix, Extra Help.

Enrichment

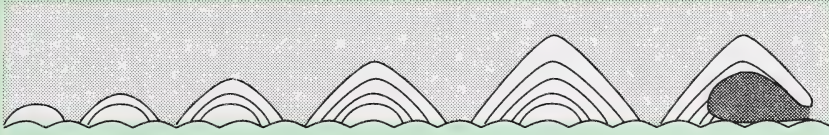
Do one of the following activities.

1. Build a small model of a quinzhee like the one shown in Figure 3.32 on page 91 in your text. Record the temperature inside and outside of the quinzhee.



To Build a Quinzhee

- Start with a small pile of snow. Pack it.
- Add another layer. Pack it.
- Add and pack multiple layers to build a mound.
- Let it set several hours, preferably overnight.
- Dig in a doorway and carefully hollow out the inside.



2. The barren-land caribou population has dropped significantly over the last 80 to 90 years. Research this subspecies of caribou and discuss the reasons for this negative population growth, the status of population today, and ways in which the herds can be protected from destruction.

You may contact either or both of the following:

Alberta Fish and Wildlife Division
Nongame Management Program
9945 - 108 Street
Edmonton, Alberta
T5K 2G6

The Canadian Wildlife Service
2nd floor, 4999 - 98 Avenue
Edmonton, Alberta
T6B 2X3

Check your answers by turning to the Appendix, Section 4: Enrichment.

Conclusion

In this particular section you have examined some of the characteristics of snow and studied how it affects the biotic components of the ecosystem. By investigating the nature of snow you've gained some understanding of the ecological role it plays in the biosphere.

Section 4 Assignment: Snow Ecology

Review the Evaluation information found in the introductory pages of this module.

It is important to number and clearly identify each page with the following information at the top:

Biology 20 – Module 2 Section 4 Assignment Page # Name and ID #

Be sure to write legibly. Leave a wide left margin and number all of your pages.

1. You are studying a deep snow pack and examining the bottom and the surface. Discuss how the two depths would differ with respect to temperature, type of crystals, and insulation. Account for the differences you observe. **(9 marks)**
2. After a wind, many projections break from snow crystals. Explain how winds affect the insulating value of snow. **(3 marks)**
3. Explain pukak layer formation. **(3 marks)**
4. Provide an example of the following types of adaptations to a winter ecosystem found in chionophiles. **(3 marks)**
 - a. anatomical adaptation
 - b. physiological adaptation
 - c. behavioral adaptation
5. Identify three ways chionophobes deal with the winter season. **(3 marks)**
6. Explain how subnivean mammals could die as a result of hypothermia. **(2 marks)**
7. A cross-country skier crosses over the snow and crushes the pukak layer. This creates a barrier for the subnivean mammals. One of the mammals attempts to cross the barrier to reach a feeding site. Provide two possible consequences of this mammal's action. **(2 marks)**

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☐ C. Organizing
- ☒ D. Analysing
- ☒ E. Synthesizing
- ☐ F. Evaluating

Reproduce the science skills assessment box after your response to this question. Remember to indicate your evaluation of your skill level for each identified science skill. Be sure to include the spaces for teacher assessment.

Self: A.	☐	B.	☐	C.	☐	D.	☐	E.	☐	F.	☐
Teacher: A.	☐	B.	☐	C.	☐	D.	☐	E.	☐	F.	☐

MODULE SUMMARY

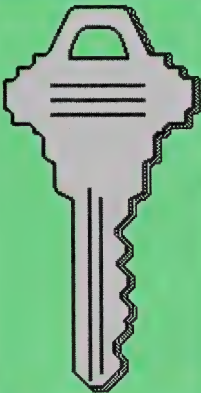
In the previous module you were introduced to the idea that the biosphere is maintained by a constant flow of energy. That's the big picture. In this module you focussed on distinct biotic and abiotic factors in the biosphere that create first, biomes and second, ecosystems. You explored both terrestrial and aquatic ecosystems and even studied snow as an additional factor. In a world where life depends on the continual flow of energy and the cycle of matter, hopefully you are gaining an appreciation for the complexity of living systems and the consequences of human impact.



If you have access to the video *Aspects of Ecology* from ACCESS Network, view the program on biomes as a general review at this time.



Appendix

	Glossary
	Activities
	Extra Help
	Enrichment

Glossary

acidic: pH reading below 7; turns litmus paper red

alkaline: pH reading over 7; turns litmus paper blue

coniferous: describing trees which usually remain green throughout the year and which have cones and needles

deciduous: describing trees which lose their leaves sometime during the year

ecotone: area of transition between biomes

emergent: aquatic vegetation that grows above the surface, such as cattails

germination: sprouting of a seed plant from a seed

herbicide: a chemical that is toxic to plants

ions: positively or negatively charged particles

pH: measure of how acidic or basic a substance is

pukak layer: open area between the snow pack and the ground

snow pack: total layer of snow from ground to snow surface

submergent: aquatic vegetation that grows totally under water

urbanization: the formation of towns and cities

Suggested Answers

Section 1: Activity 1

1. A biome is a large geographic region with characteristic climate, plant life, and animal life.

2. Abiotic factors include

- Arctic circumpolar
- extremely short growing season
- permafrost layer immediately below surface of soil which does not thaw
- low temperatures
- precipitation of 10-12 cm/y

Biotic factors include

- caribou
- rapid-flowering plants
- moss and lichens
- ptarmigan
- polar bears
- seals

3. Circumpolar means around one of the poles (North/South) of the earth.
4. From lowest to highest in terms of precipitation, the biomes are tundra, boreal forest, grassland, mixed woodland forest.
5. Members of the biotic community found in two biomes are caribou (tundra and boreal forest) and moose (boreal forest and mixed woodland forest).
6. The two biomes are tundra and boreal forest.

7.

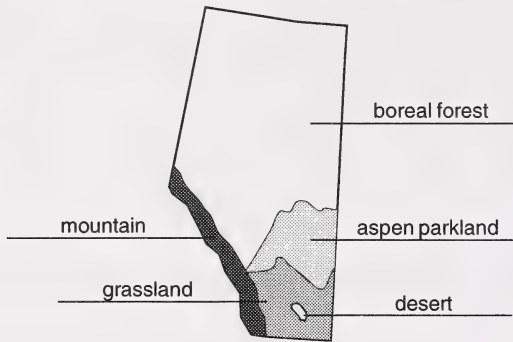
BIOME	FACTOR	ABIOTIC	BIOTIC
tundra	Arctic circumpolar	✓	
grassland	soils hold less water	✓	
tundra	rapid-flowering plants		✓
mixed woodland forest	same latitude as grassland	✓	
grassland	Plains bison		✓
tundra	extremely short growing season	✓	
mixed woodland forest	deciduous trees		✓
mixed woodland forest	woodpeckers		✓
boreal forest	precipitation of 35-40 cm/y	✓	
boreal coniferous forest	coniferous trees		✓
mixed woodland forest	increased sunlight strikes forest floor during spring and fall	✓	

8. Your check marks in the tables will vary depending on where you live. However you should be able to check one for each of the key categories – location, precipitation, dominant plant life, and animal life.
9. Answers should be based on checkmarks placed in the table. A typical response could be the following:
- The region in which I live is located north of Edmonton and gets 35-40 cm of precipitation. It consists of coniferous trees with animals like hares, lynx, and moose.
10. If you live in any of the biomes discussed already, you should be able to identify it. Otherwise you will be able to identify the biome where you live from the next activity.

Section 1: Activity 2

- Other land regions include areas covered mainly with grass, deciduous trees, or barren land regions. Most of southern Alberta and Saskatchewan is grassland while most of Manitoba and Ontario is boreal forest.
- mixed woodland forest – due to the presence of deciduous trees
 - tundra – due to the barren land
 - grassland – because of the presence of mainly grasses
 - boreal forest – because the dominant plant life is coniferous trees
- 0° latitude is located at the equator.
 - 90° latitude is located at the poles.
 - As you move from 0° to 90° latitude you are moving towards the North or South poles.
- As latitude increases from 0° to 90° the biomes decrease in temperature and amount of plant life.

- b. As altitude increases the biomes decrease in temperature and amount of plant life.
 - c. The relationship is the same in that whether altitude or latitude increases, there is a decrease in both temperature and vegetation.
5. Aspen parkland is an ecotone between the boreal coniferous forest and the grasslands.
- 6.



Section 1: Activity 3

1. The grassland biome is a major food producer.
2. Alberta's boreal forest supports an important timber industry.
3. Nearly 10% of the world's forests are in Canada.
4. Forests remove carbon dioxide and add oxygen to the atmosphere. They also help clean and filter water in watersheds and provide important habitat for wildlife.
5. Forests are an important natural resource for the recreation and tourism industry.
6. Early Canadian forestry used axes and hand saws for harvesting; and horses, waterways, and railways were used for transportation.
7. Today cutting and limbing machines and chainsaws are used to cut trees. Skidders and large trucks transport logs from the forest to the mills.
8. Logging in Nova Scotia is much older than in British Columbia. In Nova Scotia forests have been harvested for over three hundred years. Many Nova Scotia forests have been cut and regrown up to three times. In British Columbia many forests are just being cut for the first time. In Nova Scotia most of the prime timber has been cut long ago. Only inferior trees remain. In British Columbia prime forests still exist.
9. An old growth forest consists of very old, very large trees. These trees have never been harvested.
10. The old growth forests in Nova Scotia were cut long ago.
11. Christmas tree farming is a fairly new industry in forestry.

Section 1: Follow-up Activities

Extra Help

- biosphere
 - biome
- abiotic
 - biotic
 - biotic

3.

BIOME	ABIOTIC AND BIOTIC FACTORS
grassland	• grasses • less precipitation than mixed woodland • hawks • rattlesnakes
mountain	• widest range of altitudes • collection of biomes • mountain goats • bighorn sheep
chaparral	• mild winters • hot, dry summers • fruit-eating birds • seed-eating rodents

BIOME	ABIOTIC AND BIOTIC FACTORS
tundra	• low temperatures • precipitation of 10 to 12 cm/y • polar bears • seals
desert	• wide-ranging temperature extremes • low irregular precipitation • cacti • lizards, snakes
mixed woodland forest	• south of boreal forest • precipitation of 100 cm/y • deciduous trees • woodpeckers
temperate rain forest	• warm temperatures • high humidity • giant coniferous trees
boreal coniferous forest	• south of tundra • precipitation of 35 to 40 cm/y • evergreen trees • moose

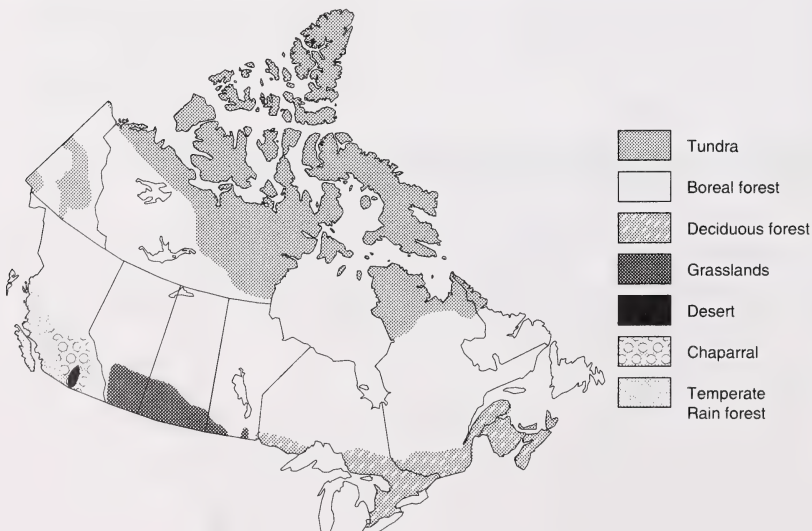
4. Ways the human species has contributed to the destruction of forests include

- cutting down of trees
- burning of forests
- turning forests into grazing regions for cattle

Enrichment

1. You should attempt to identify specific animal and plant life in the biome of study. To study abiotic factors, use various resource people like local meteorologists and ecologists.

2.



3. Use resource people such as a park naturalist or biologist to assist with the field trip. Besides lending knowledge and experience, they may be able to discuss research and careers.
4. Collages will vary depending on your sources but watch for common themes, i.e., uses by industry or tourism.
5. The first group, Alberta Junior Forest Warden Association, is recommended and don't forget 4-H.

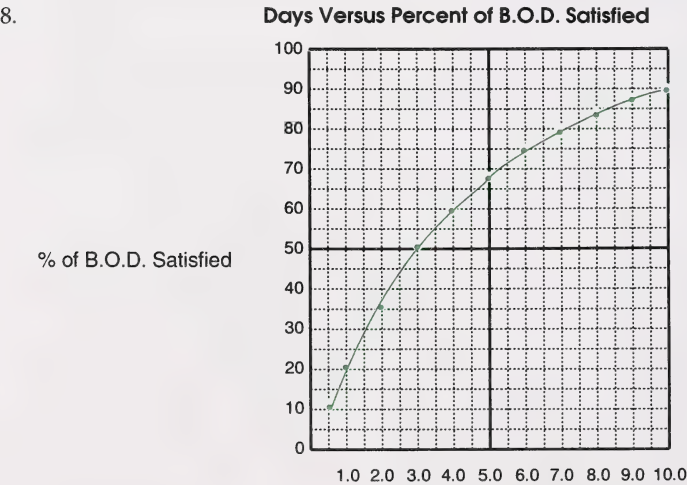
Section 2: Activity 1

1. One site should have a higher light intensity than the other and plant life should vary. With respect to plant life, one site may have trees and the other will not.
2. It is important to read the thermometer immediately so that the reading is accurate for the area you wish to measure.
3.
 - a. Averages should be calculated by taking the measurement total for a particular category and dividing by the number of measurements taken.
 - b. Your data should be consistent in that all the values for Site 1 should be higher or lower than those for Site 2.
4. If you were comparing a grassland site with a deciduous forest site, you would find the temperature in the grasslands to be warmer than in the deciduous forest.
5. A grassland site would receive less precipitation than a forest site on a large scale. You may not notice any differences between your sites.
6. As the amount of precipitation decreases in an area, the amount of plant life decreases. Lower amounts of precipitation result in more grasses and herbs, whereas higher amounts result in more shrubs and trees.
7. Alkaline soils may have somewhat basic pH values above 7.0. More acidic soils have a pH of 6.0 or less.
8. As a general rule, dry areas will usually have alkaline (basic) soils while wet areas will have acidic pHs.
9. Hopefully you can tell differences in light intensity in the two sites. One site may simply look brighter than the other. More precise measurements may be taken using a light meter.
10. Other factors include altitude, topography, time of year, time of day, and cloud cover.
11. The sun is the source of energy for life. It controls the amount of heat, amount of precipitation, and numbers of producers and consumers.
12.
 - 1 penetration of solar energy
 - 3 influences animal life in the site
 - 4 determines plant life in the site
 - 2 abiotic factors like temperature and moisture
 - 5 determines the type of biome
13. Other abiotic factors include wind and relative humidity.

14. Litmus paper would not be suitable here. It does not provide numerical measurements. With litmus paper, you could get an alkaline reading, but this would not necessarily mean that it was an acceptable area for growth. Values of 8.0 and 11.0 give alkaline readings but would not allow growth of this species.

Section 2: Activity 2

- 1. The marine community contains large amounts of salt, whereas the freshwater community has less.
- 2. Standing-water formations may include lakes, ponds, bogs, sloughs, or other types of wetlands.
- 3. Running-water ecosystems include permanent and temporary, slow- and fast-running streams.
- 4. Light usually reaches the bottom of a pond but may not reach the bottom of a lake. This is a result of differences in depth.
- 5. You would likely find that as you sample deeper water, the temperature gets colder. If you compare standing water with a running-water ecosystem, you would likely find the temperatures to be colder in the running-water ecosystem.
- 6. Answers will vary depending on the type and numbers of living organisms in the ecosystem and on whether flowing or standing water was used. If there are a large number of animals living on or near the surface, they would use up large amounts of oxygen. This would result in a lower oxygen level than if there were only a few animals living at this depth.
- 7. Yes, there is a relationship. As temperatures become colder, there is a higher value for percentage of biochemical oxygen demand satisfied. Cold water can hold more oxygen.



9. As the number of days increases, the biochemical oxygen demand satisfied increases.

10. Possible errors could include

- faulty measuring instruments
- human measuring error
- not enough trials done to get a representative sampling
- selection of site not appropriate
- others?

11. If the two sites of study were quite different, you should expect different organisms to live in each of the areas since they differ in a number of abiotic factors. These factors include temperature, hardness, oxygen demand satisfied, and pH.

12. • Textbook question 1: The aquatic environment is only exposed to the atmosphere at its surface. The greater density of water compared to air gives water a much higher heat capacity. Water neither warms nor cools as quickly as air and it retains heat energy.
- Textbook question 2: Freshwater communities include terrestrial lakes and rivers. Great variation exists between freshwater communities depending on temperature, size, oxygenation, and rate of flow. Freshwater communities are relatively shallow. Marine communities exist in salt water in oceans. Variation occurs due to differences in temperature and depth, but all communities must contend with the high salt content of the water.
- Textbook question 3: Generally lakes are larger and deeper than ponds. Light may not penetrate to the bottom of lakes. Photosynthesis in lakes occurs in the shallow littoral and limnetic zones. In ponds, shallow water lets light penetrate to the bottom. Photosynthesis occurs throughout the pond.
- Textbook question 4: Brackish water occurs where freshwater flows into oceans and in some lakes where evaporation rates are high and salts become concentrated.
- Textbook question 5: Temporary standing water occurs when rain or melting snow creates temporary ponds. These disappear with drainage or evaporation.

13. Your table might look like this.

	OLIGOTROPHIC	EUTROPHIC
Depth	deep	shallow
Temperature	cold	warm
Nutrients	low	high
Clarity	clear	murky
Organisms	low	high

14. • Textbook question 8: Littoral is shallow and near the shore. Limnetic is shallow but away from the shore. The profundal zone is in deep water. Light penetrates the littoral and limnetic zones but not the profundal zone.
- Textbook question 9: Plankton refers to organisms that float or drift free in the water. Plankton is the basis for many aquatic food chains.

- Textbook question 10: Fall turnover in lakes serves to carry oxygenated water through all depths.
- Textbook question 11: Arctic lakes may remain frozen year-round some years. High but brief summer temperatures may cause only one seasonal turnover.
- Textbook question 12: Temperature and dissolved oxygen are closely related. As temperature rises, solubility of oxygen decreases so dissolved oxygen will be less.
- Textbook question 13: A thermocline forms when there is a distinct difference in temperature and density between two layers of water. Generally a less dense, warm layer lies above a more dense, cool layer.
- Textbook question 14: An algae bloom is a sudden increase in the amount of algae in water. This is usually due to an increase in temperature, sunlight, or nutrients such as phosphates. Unfortunately, when the algae dies, decay causes a depletion of oxygen. This may kill many other species such as fish.
- Textbook question 15: Pond succession begins with a bare pioneer stage. This is followed by algae and submerged vegetation which begin adding material to the lake bottom. Vegetation continues to grow and as it dies adds more material to the bottom of the pond. Gradually the pond fills in to become a meadow and finally a forest.
- Textbook question 16: Waste runoff from a cattle ranch may add nutrients or fertilizer to a lake or pond. The increased nutrients cause rapid plant growth which increases the amount of organic material accumulating in the lake.

Section 2: Activity 3

1. The prairie provinces – Alberta, Saskatchewan, and Manitoba – contain grasslands.
2. The grasslands are located in the southern part of the provinces.
3. The native ecosystems almost eliminated include the tall-grass prairie and plains fescue.
4.
 - a. Eighty-seven percent of prairie grassland has been converted to farmland. This has resulted in loss of organic matter and plant nutrients.
 - b. These systems have been extensively modified and developed for hydro and thermal power generation, irrigation projects, flood protection, and water management.
 - c. Irrigation accounts for 46% of water withdrawal. It also accounts for 69% of total water consumption.
 - d. Water levels are close to minimal levels in some areas due to economic, social, and climatic trends.
 - e. A large amount of the grasslands has been converted into towns and cities.

Section 2: Follow-up Activities

Extra Help

1. Probably Planet B would be the area of your choice. The climate is much warmer. There is an abundance of plant and animal life which can be used for food. All living things are going to move into an area which is most productive for them – favour survival. The abiotic factors determine what the environment is going to be like. It should be noted that there will be some organisms which will favour Planet A.

2. a.

FISH	OPTIMUM TEMP. (°C)	PREFERRED DEPTH
trout	15	bottom
perch	24	depth 1
carp	32	surface

b.

The Preferred Depth of Some Common Fishes



c. The temperature of the water determines the preferred depth. The place where food is available could be a biotic factor.

3. a. The new temperatures are

- surface → 40°C
- depth 1 → 35°C
- depth 2 → 30°C
- bottom → 25°C

b. Optimum temperature for trout will not occur anywhere in the lake. The trout will die. The perch will have to move to the bottom to find a temperature close to 24°C. Carp will occupy most of the lake.

- c. Humans, through industrial pollution – specifically thermal pollution – would have caused the changes to the populations of fish in the lake.

Enrichment

1. A light meter in a single-reflex camera can be used for this. Test the difference in light intensity between bright sunshine and shade.
2. Other variations of this experiment are possible. For example, you might compare sunlight to artificial light. Other types of plants can be tried as well.
3. For information on Hach kits write to either of these addresses:

ANACHEMIA SCIENCE	PRAIRIECHEM INC.
15006 - 116 Avenue	1919 - 84 Avenue
Edmonton, Alberta	Edmonton, Alberta
T5M 3T4	T6P 1K1
4. People in North America tend to take the quality of their drinking water for granted. This is not common in many other countries. Have you ever noticed a change in the odour or taste of your drinking water? Do you know if your water is tested occasionally?
5. Pollution in drinking water can include contaminants from domestic or industrial sewage or runoff from storms.
6. A beginning could be an investigation of control of drinking water quality in the area where you live.
7.
 - a. hygrometer – used to measure humidity
 - b. anemometer – used to measure wind velocity
 - c. Secchi's disk – used to measure transparency (visibility) in water

Section 3: Activity 1

1.

ZONE	DEPTH	TEMPERATURE	LIGHT
Littoral	shallow edges of body of water	warmest depth	greatest light
Limnetic	open area of water where light penetrates	as the zone increases in depth, it gets colder	as the zone increases in depth, there is less light
Profundal	under the limnetic zone	colder than limnetic	darker than limnetic
Benthos	bottom of body of water	coldest depth	least amount of light
2. Plankton refers to both photosynthetic and nonphotosynthetic microscopic organisms. Phytoplankton refers to plant-like organisms whereas zooplankton refers to animal-like organisms.

3. Yes, you should have found different species in different areas. Abiotic factors such as depth of water, light intensity, and dissolved oxygen level are responsible for the different species in different areas.
4. Any three plant species are acceptable assuming they are photosynthetic.
5. Any three animals are acceptable as they are not photosynthetic. Notice that consumers include protozoans and arthropods.
6.
 - a. Yes, there is material (waste, dead material) which needs to be broken down.
 - b. If you had access to a compound microscope, you would have been able to observe bacteria. Species of fungi could have also been observed. An obvious sign of decomposers at work can be the strong odours around ponds.
7. You should have observed a greater abundance of plant species and fewer numbers of animal species. For example, you should have seen more cattails than toads.

Section 3: Activity 2

1.

Human Activity	Source of Pressure
Agriculture	• clearing of forests, draining wetlands, cattle grazing, use of herbicides and pesticides
Forestry	• logging, logging roads, hydroelectric lines
Acid rain	• industrial pollution causing major damage to aquatic ecosystems
Toxic contaminants	• industrial manufacturing processes, pesticides, fertilizers
Introduced species	• bringing in of species which may be diseased or that compete with native species
Climatic change	• fossil fuel combustion and removal of forests contribute to the greenhouse effect
2. Biological diversity refers to the variety and variability that exist among living organisms.
3. The greater the biological diversity the more healthy the ecosystem.
4. Humans have negatively affected biological diversity by
 - clearing land for agriculture
 - using pesticides and herbicides
 - logging
 - burning fossil fuels
 - producing toxic contaminants through industry
5. Negative human pressures result in
 - reducing/eliminating natural habitats
 - killing species (toxic effects)
 - creating competition between species possibly leading to the elimination of one species
6. The zebra mussel removes phytoplankton which serve as a food source for many fish such as walleye, trout, bass, and perch. It delays migration of some waterfowl since they feed on zebra mussels. The shells may severely restrict water flow.

Section 3: Follow-up Activities

Extra Help

1. a. Any five of the following are acceptable:
 - willows
 - pine
 - algae
 - water lilies
 - cattails
 - alder
 - duckweed
 - b. Any ten of the following are acceptable:
 - hawk
 - butterflies
 - duck
 - segmented worms
 - minnows
 - sticklebacks
 - copepods
 - water striders
 - raccoon
 - flies
 - carp
 - flatworms
 - roundworms
 - snails
 - beetles
 - freshwater clams
 - crayfish
 - bass
 - frog
 - c. The decomposers are the bacteria. The dead plants and animals would not be broken down. They would simply build up and hold matter that should cycle.
 - d. The animals, plants, and decomposers in an ecosystem make up the **biotic** components of the ecosystem.
 - e. There would be approximately twenty-six species.
 - f. In a healthy ecosystem a large variety of organisms should be present.
2. a. The producer is the grass and the consumer is Species A.
 - b. You would expect to have more producers than consumers. If there were more consumers than producers, eventually the producers would all be eaten and the consumers would not have a food source.
3. You would eventually perish. Clearing the trees would result in your habitat eventually disappearing and your food source becoming nonexistent.

Enrichment

1. Try leaving a lid on your terrarium to maintain humidity. Animals might include worms and insects.
2. Be sure to follow up any materials you receive with a thank-you letter.
3. As with a terrarium, your aquatic ecosystem may be covered. This makes it similar to the “closed system” of the earth.
4. This could be done in summer or winter. Always exercise caution around water.
5. Remember your thank-you letter.
6. This investigation should be done under supervision. It also might be considered as a Science Fair Project.

Section 4: Activity 1

1. See Table 3.3 on page 78 in your text.
2. As an insulator snow can actually reduce heat loss. Light, fluffy snow is the best type for insulation.
3. Woolen socks lose their insulating value because water enters many of the air spaces, making the socks more dense. Then the socks become better conductors than insulators. Your feet will feel colder faster. This is partially offset by oil (lanoline) in natural wool that repels water. Wool still containing lanoline will continue to act as an insulator even when wet but it gets very heavy and smells!
4. The temperature is warmest at the snow ground interface. It is coldest at the snow surface. At the bottom there is more insulation therefore it is warmer. At the surface there is less insulation therefore it is colder.
5. Check on page 86 of your text. As snow crystals change to a spherical shape (corn snow) they lose their grip on a slope and can easily start an avalanche.
6. The pukak layer forms through sublimation. Sublimation in this case, refers to the snow crystals turning into water vapour and moving up the snow pack and recrystallizing in the cooler snow. This creates the space between the ground and the snow pack.
7. The pukak layer allows animals to move about in search of food in an insulated snow-free zone.
8. The pukak layer may only be one or two degrees below freezing or warmer. Look at Figure 3.31 on page 91 in your text.
9. Is the appearance coarse or fine, hard or soft, large or small crystals?
10. Can you find a subnivean space along the ground?
11. This allows you to get an accurate measurement at each depth. It takes time for the thermometer to change.
12. It must be read immediately so that the air temperature has little effect on the thermometer reading.
13. Student data will vary depending on conditions.
14. A good snow pack for investigation is at least 20 cm deep.
15. Compare to the snow crystals in Figure 3.24 in your text. Note that the oldest snow should be at the bottom of the pack.

Section 4: Activity 2

1. chionophobe – animal that does not like winter conditions and tries to avoid its conditions
chioneuphore – animal that is able to withstand winter conditions
chionophile – animal that has adapted very well to snow conditions

2.

ANIMAL	CHIONOPHOBIC/ CHIONEUPHORE/ CHIONOPHILE	RESPONSE TO WINTER
caribou	Chionophobe	migrates away from winter conditions
chipmunk	Chionophobe	hibernates during winter months
<i>Bracon cephi</i>	Chionophobe	prevents freezing by supercooling water in body or converts body water to glycerol
wood frog	Chionophobe	freezes solid and waits out the winter
elk	Chioneuphore	becomes winter browser feeding off buds, twigs, and bark of trees and shrubs
snowshoe hare	Chioneuphore	molts to a white coat
ruffed grouse	Chioneuphore	buries itself in the snow to survive intense cold nights
arctic fox	Chionophile	has small protruding body parts to prevent heat loss – small, rounded, fur-covered ears
musk-ox	Chionophile	grows a long shaggy coat

3. Counter-current heat exchange is where warm blood flows beside cold blood and results in the warm blood cooling down and the cold blood warming up slightly. The purpose is to reduce heat loss from the extremities. Look at Figure 3.20 on page 84 of your text and carefully read the first paragraph under the figure.
4. • Some protection against predators occurs for animals such as mice and voles.
- High humidity reduces evaporation which in turn reduces heat loss in the subnivean environment.
- Protection against lower air temperatures is perhaps the most critical advantage to organisms in this environment.
5. As the density of the snow increases, the insulation value decreases.
6. Conifers such as spruce and pine trees have resins within vascular tissues that act as antifreeze. Super cooling, that is cooling below the freezing point without forming crystals, also helps. The conical shape of their main branches as they radiate outward and down transfers snow load to the ground before breaking.
7. • Prior to the appearance of permanent snow, if temperatures drop and there is no snow cover, many animals die of hypothermia.
- A midwinter thaw which increases density and reduces snow pack depth can reduce insulation values.
- A freezing sleet can form a crust of ice and prevent proper exchange of O_2 and CO_2 or block passage up through the snow for mammals.
- A spring thaw too early in the winter can cause a loss of snow cover. If this is followed by cold weather, many mammals may die of hypothermia.

Section 4: Follow-up Activities

Extra Help

1. Both temperature and snow density decrease as you move upwards.
2. Insulation also decreases moving upwards; it is warmest at the bottom.
3.
 - a. migrate
 - b. hibernate
 - c. freeze
 - d. adapt

Enrichment

1. Building a quinzhee takes a little practice and patience. It also works very well in cold weather. You may learn quite a lot about how snow changes after being disturbed.
2. Be sure to provide an explanation of why you are seeking information; be as specific as possible.



NOTES

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